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ABSTRACT

Energy activities and lesson plans for grades 9 and 10 (grouped into seven units representing seven major conceptual schemes) are provided in this teachers' guide, with a unit at each grade level for each conceptual scheme. Conceptual schemes addressed include: (1) energy is the ability to do work; (2) energy comes from the sun; (3) energy can be changed from one form to another; (4) the sun is the earth's chief source of radiant energy; (5) people use energy to satisfy their needs; (6) energy supplies are limited; and (7) living things are interdependent with one another and with their environment. Each unit includes a pre-/post-test evaluation instrument, lesson plans, and supplemental activities. Lesson plans consist of a specific energy concept, objective, and instructional strategies for introducing, developing, and extending the lesson. Purpose, materials, and procedures are provided for each of the supplemental student activities. The guide begins with a brief introduction to teachers and statement of the energy policy for Florida and concludes with a list of key vocabulary words (Enerwords), bibliography, sources of energy information and teaching materials, and an evaluation sheet. (JN)

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ENERGY & MY ENVIRONMENT

9-10
TEACHERS GUIDE

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ENERGY AND MY ENVIRONMENT

TEACHERS' GUIDE
FOR
GRADE NINE AND GRADE TEN

Written by:
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June 1982

Governor's Energy Office
State of Florida

We are all parts of a great Web of Life - -
Powered by the Sun - -
All interdependent with the others.....

John H. Storer
1938

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FOREWORD

This Grade Nine through Grade Ten teachers' guide is the fourth of a series entitled ENERGY AND MY ENVIRONMENT. Other volumes of this series are:

ENERGY AND MY ENVIRONMENT, K - 3 Teachers Guide
ENERGY AND MY ENVIRONMENT, 4 - 6 Teachers Guide
ENERGY AND MY ENVIRONMENT, 6 - 8 Teachers Guide
ENERGY AND MY ENVIRONMENT, 11 - 12 Teachers Guide

After participating in many curriculum development and educational planning projects, the editors recognized one element that permeates those which were most successful. That element is the establishment of major ideas which serve as recurring themes throughout the child's educational experiences. This publication is designed to integrate key energy and energy conservation ideas in just such a manner.

The State of Florida was most fortunate indeed in obtaining the services of Dr. Matthew J. Brennan as the author of this series of teachers' guides. His work as editor on the PEOPLE AND THEIR ENVIRONMENT series established him as one of the founders and principal practitioners of this cognitive theme approach.

Through the Tri-County Teacher Education Center, Sebring, Florida, teachers were employed to select supplemental activities to accompany the lessons prepared by Dr. Brennan. Funds for this activity were provided through the mini-grant program of the Office of Energy and Environmental Education, Florida Department of Education.

These materials are designed to provide the flexibility that any good teacher demands, yet provide the recurring themes which may well be essential if the lessons are to have any lasting impact on the student. These materials can play an important role in the development of a citizenry which thinks and acts on a basis of factual knowledge of key energy concepts and also possesses an understanding of the great national and international web of energy relationships and interdependencies important for the citizen of today and essential for the citizens of the future.

The editors wish to thank the dedicated educators who have contributed their time and expertise to make this series, ENERGY AND MY ENVIRONMENT, available to the teachers in Florida's schools. A special thank you goes to secretaries Edie Boynton and Patricia Patrick for the long hours spent preparing these manuscripts for printing, and to Mary Lou Stursa and Dr. Rodney Allen for their expert assistance.

The Editors

INTRODUCTION - TO THE TEACHER

Is there an "energy crisis"? There has always been an energy crisis, as humans struggled to survive on planet earth. Now we face a new energy crisis - a crisis related to the future supply of the fossil fuels on which our civilization depends. This new energy crisis provides unlimited possibilities for student activities that will help children learn about the earth, how the use of energy has shaped civilizations of the past and present, and how it will determine the civilizations of the future.

Through their use of energy, humans have radically changed the environment. Now we must face the consequences of these changes, not only on the environment, but on all of life, including our own; on our societies; on our economies; on the air we breathe and the water we drink; on the life-styles we lead; on the quality of the environment; and on the lives of the animals with whom we share the earth. The changes were made by people. The problems they have created can be solved only by people - indeed, by people who wish to solve them.

So we have reached the "crisis." The fossil fuels, which gave us unlimited supplies of cheap energy, are being depleted rapidly. The time for decision has arrived. How will we answer? We have the technology to solve most of the energy-related problems of the earth environment. Whether we solve these problems will depend on how clearly they are recognized and whether our values will demand their solution. It is hoped that the activities in this guide will help students to understand the scientific, social, and aesthetic alternatives that must be considered.

The activities have been organized around the seven major conceptual schemes relating to energy, with a unit at each grade level for each one of the conceptual schemes. In addition, there is a lesson concept for each lesson and supplemental activities to help the teacher coordinate the activities with other areas of the curriculum. Each lesson is designed to suggest some activity, with the emphasis on "suggest," because students and teachers will be free to interpret each activity suggestion as they will.

You will have many ideas for variation and improvement of the lessons suggested and the supplemental activities.

PLEASE RETURN THE REVIEW SHEETS LOCATED IN THE BACK OF THIS BOOK. IT IS NECESSARY THAT WE HAVE INFORMATION FROM YOU FOR EVALUATION PURPOSES.

ENERGY POLICY FOR FLORIDA

WHEREAS, energy availability strongly impacts upon every aspect of human existence and the conservation of energy resources is essential to the health, safety, and welfare of the people of this state and to the well-being of the state economy, and

WHEREAS, Florida is particularly dependent upon other states and nations to supply its energy needs, and

WHEREAS, the majority of Florida's energy requirements are obtained from petroleum and natural gas, and the supply of these fuels is subject to interruption, and

WHEREAS, wasteful, inefficient, uneconomic, and unnecessary use of energy will result in a serious depletion of energy resources and represents a potential threat to preserving the health, safety, and welfare of the people of Florida, and

WHEREAS, alternative sources of energy are years from being fully developed and there is a pressing need to accelerate research and development of these sources, and

WHEREAS, energy conservation represents a meaningful, immediate, and appropriate state response to the energy problem by eliminating waste and inefficiency and increasing economic productivity, by reducing the depletion of our domestic energy resources which, in turn, increases economic flexibility of the people of Florida, and by decreasing the pressure to develop marginally efficient methods of energy production and thereby reducing the flow of capital from the non-energy sections of the economy and avoiding serious impacts on our environment, NOW, THEREFORE, BE IT RESOLVED

IT SHALL BE THE POLICY OF THE STATE OF FLORIDA TO:

1. Develop and promote the effective use of energy in the state and discourage all forms of energy waste.
2. Play a leading role in developing and instituting energy management programs aimed at promoting energy conservation.
3. Include energy considerations in all planning.
4. Utilize and manage effectively energy resources used within state agencies.
5. Encourage local governments to include energy considerations in all planning and to support their work in promoting energy management programs.
6. Include the full participation of citizens in the development and implementation of energy programs.
7. Consider in its decisions the energy needs of each economic sector, including residential, industrial, commercial, agricultural and governmental uses.

8. Promote energy education and the public dissemination of information on energy and its environmental, economic and social impact.
9. Encourage the research, development, demonstration, and application of alternative energy resources, particularly renewable energy resources.
10. Consider in its decision making the social, economic and environmental impacts of energy-related activities, so that detrimental effects of these activities are understood and minimized.
11. Develop and maintain energy emergency preparedness plans to minimize the effects within Florida of an energy shortage.

(Chapter 377.601, Florida Statutes)

GRADE 9

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Title: A Solar Farm

Concept: People use energy to do their work.

Objective: To discover the relationship between direct solar energy and people's use of it

Introducing the lesson:

1. Ask the students to suggest words that describe a farm. Write them in columns on the chalkboard as fast as you hear them. Make it a game to go faster than they do.
2. Read in the Meinel Book, "Power For The People," or in the NSTA Source Book about the Meinel proposal to build a huge solar "farm" in the southwestern U.S.

Developing the lesson:

1. Investigate the cycle for capturing the sun's energy and using it. (trap solar radiation in collectors; pump heat to a central power plant; generate steam; and produce electricity with steam turbines)
2. Describe the "rows" on the farm. (Rows of solar collectors with mirrors to focus sunlight on black pipes are filled with liquid sodium to carry the heat. The whole collector is enclosed in a transparent vacuum half-cylinder.)
3. Ask: What is the crop? (heat - temperatures as high as 1000 degrees Fahrenheit)
4. Ask: What happens on cloudy days? (Heated sodium flows to a storage tank which could hold heat for a few days and continue to generate electricity.)
5. Investigate how much electricity could be produced on a solar farm. (A farm of 10,000 square miles, 100 miles on a side, could produce half of the nation's need for electricity in the year 2000, according to Meinel.)
6. Ask: Isn't that a lot of land to use? (Yes, but in the southwestern U.S., 10,000 square miles is only a tiny fraction of the area of relatively unused desert.)
7. How does the efficiency of a solar farm compare with the efficiency of a standard electric generating plant? (Both operate about 30% efficiency, but after the initial installation of the solar collecting equipment, fuel is free.)

Extending the lesson:

1. Draw a picture or diagram of a solar farm.

GRADE 9, UNIT 1, LESSON 1
(Continued)

2. Discuss this use of direct solar energy by people.
3. Ask: What could a development like the solar farm proposed by Meinel do for the future? (cheap, plentiful electricity, although there would still be a great loss in transmission of electricity if all the solar farms for the U.S. were located in the southwestern U.S.)
4. Debate whether or not it would be feasible to set aside 10,000 square miles of Florida land to build a solar farm. (Would it be as good as to use land for citrus farming?)
5. Start a class energy vocabulary list.

GRADE 9, UNIT 1, LESSON 2

Title: Efficiency

Concept: People's machines waste energy in doing work.

Objective: To discover the relationship between the efficiency of people and machines

Introducing the lesson:

1. Ask the class to describe an efficient person. (one who gets work done with an apparent minimum of effort or wasted energy)
2. Discuss whether the same definition of efficiency would apply to a machine. (Yes, the efficiency of a machine is the ratio of the work done to the energy used to do the work.)

Developing the lesson:

1. Find out how efficiency is determined. (Divide work done by energy used and multiply by 100 = % efficiency.)
2. What is lost that determines efficiency? (heat)
3. Ask the students to rate the following energy conversion processes in terms of their efficiency from highest to lowest. (These are in the correct order; be sure to give them to the students in a different order.):

electric generator - 95 %

steam power plant - 40%

dry cell battery - 90%

diesel engine - 35%

GRADE 9, UNIT 1, LESSON 2
(Continued)

large electric motor - 90%

automobile engine - 25%

storage battery - 75%

fluorescent lamp - 20%

small electric motor - 65%

steam locomotive - 10%

steam turbine - 50%

incandescent light bulb - 2%

4. Compare our major uses of energy with the efficiency ratings; for example, one-fourth of our energy is used in producing electricity in plants with an efficiency of 30% or less.
5. Compare use and efficiency for transportation.
6. Ask: Why are engines so inefficient? (Many moving parts, plus burning fuel = a lot of heat loss.)
7. Investigate how the efficiency of automobiles expressed in miles per gallon has been increased in recent years. (lighter cars, high compression; could be increased more except for use of air-conditioning)
8. Ask: What helps to keep automobile efficiency low? (automatic transmissions, power brakes, air-conditioning)

Extending the lesson:

1. Deliver a two-minute sermon on the evils of inefficiency.
2. Draw a picture of an inefficient, low-energy transportation system. (hiker, Himalayan porters, bicyclist, etc.)
3. Describe your efficient transportation.
4. Compare the efficiency of automobiles and airplanes in moving 100 people from Atlanta to Tampa. (According to one of the major airlines, a Boeing 727 uses approximately 1860 gallons of fuel per hour. It is approximately $1\frac{1}{2}$ hours flying time from Tampa to Atlanta. The 727 would use approximately _____ (2800) gallons of fuel from Tampa to Atlanta. If automobiles average 16 miles per gallon and the distance from Tampa to Atlanta is 960 miles, it would take _____ (60) gallons of fuel for an automobile to go from Tampa to Atlanta. At the average of 2 persons per automobile, at the above rate, how many gallons would it take for 100 persons in 50 cars? _____ (3000) Calculate the amount of gallons required to take 100 persons in a 727 and by automobile (varying numbers of passengers per automobile). Make up your own problems and do calculations using the following data:

GRADE 9, UNIT 1, LESSON 2
(Continued)

<u>Type of Plane</u>	<u>Number of Gallons</u>	<u>Passenger Limits</u>
Boeing 727	1860 per hour; 31 per min.	137
DC-10	2730 per hour; 45 per min.	327

Even without the above data, you should know that it is more energy efficient to fly on a regularly scheduled airliner. Why? (Planes will be flying anyway.)

5. Make the same comparisons for trains and trucks used to move freight. (Trains use one-fourth of the amount of energy to move the same amount of freight.)
6. What other factors might be considered in deciding how to move freight. (perishable cargo, etc.)
7. What other factors increase overall efficiency of trains as compared to automobiles? (Trains use energy to move their cargo; most energy used in cars is used to move the vehicle, not the cargo)
8. Add new energy words to the class energy vocabulary list.

GRADE 9, UNIT 1, LESSON 3

Title: Sea Thermal Power

Concept: The ocean is a huge solar collector and heat engine.

Objective: To discover the relationship between ocean temperature gradients and heat engines

Introducing the lesson:

1. Every person in Florida knows about the warm Gulf Stream which flows north along the east coast of Florida. Ask the students if there is any way that the heat energy of the Gulf Stream could be used. (Yes, the ocean is a natural heat engine which could produce electricity if its energy could be captured.)
2. In solar power proposals like the solar farm in lesson 1, collectors of solar heat are often too expensive to make the project economically feasible. Ask: What is the solar heat collector in the Gulf of Mexico? (The sea itself collects the heat, free.)

Developing the lesson:

1. Find out how a heat engine works. (A heat engine is placed between a high temperature source, the ocean surface, and a low temperature source, deep water in ocean. Heat flows from hot to cold through the heat engine, which converts it to work for electric power production.)
2. Ask: Why is the Gulf Stream a good location for use of a heat engine to produce electric power? (There is a year-round difference of about 40 degrees between the surface and water 1000 feet below the surface with no seasonal or daily variations.)
3. Investigate the research of the French scientist Georges Claude and his development of a sea thermal steam turbine in Cuba in the 1920's.
4. Describe the operation of the Claude power plant in Cuba. (A vacuum pump brought warm surface water to a boil by reducing pressure. Steam was used in a turbine to produce electric power.)
5. Why were larger plants not built when they were so successful? (They could not compete economically with plants using newly-developed oil resources.)
6. Investigate efforts by the French government to build a sea thermal power plant.
7. Read in Clark's "Energy for Survival" about the proposals of the Andersons of York, Pennsylvania, and Dr. William Heronemus of the University of Massachusetts to use sea thermal power plants to produce electricity or hydrogen for fuel.

Extending the lesson:

1. Some areas of Florida are short of fresh water. Investigate the dual use of a sea thermal power plant to desalinate sea water.
2. Describe the advantages of an underwater ocean power plant. (no storm problems)
3. How would such a system work in polar regions? (Even the cold ocean can be a heat source, like the inside of a refrigerator can give off heat, as long as there is colder air around to act as a heat sink for the plant's condensers.)
4. Investigate the possible effects on marine life of a sea thermal power plant in the Gulf Stream. (Cold water brought up from bottom would be beneficial to marine life. The greatest concentrations of marine life in the world are in areas where currents bring nutrient-rich cold water to the surface.)

GRADE 9, UNIT 1, LESSON 3
(Continued)

5. Investigate how electricity produced could be used to produce hydrogen for a hydrogen-based energy economy. (Instead of sending electricity ashore, it would be used to make hydrogen by electrolysis of water. This hydrogen could be transported in existing gas pipelines to local fuel cell plants to make electricity.)
6. Ask: Why don't we build it?
7. Add to the class energy word list.

Title: Animal Power

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy sources and power

Introducing the lesson:

1. Find pictures of various animals being used to do work for people.
2. Make a list of the different animals that have been used by people.

Developing the lesson:

1. Ask: What animals were first used by people? (slaves captured in battle - human power)
2. Investigate the use of slave labor in building pyramids, Roman cities, etc.
3. Investigate slavery among Indian tribes.
4. How were other animals first used? (to carry loads and pull loads)
5. How did the invention of the wheel increase the efficiency of animal labor? (reduced energy lost to friction in dragging loads)
6. Rate animals used by man in terms of their strength. (elephant, horse, ox, mule, camel, reindeer, llama, man, dog)
7. Discuss the most unusual animal used by people. (probably reindeer by Laplanders)
8. Investigate the use of dogs in polar exploration.
9. Which animal is most versatile? (horse)
10. Which animal is most widely used? (horse)
11. What is horsepower and why is it used as a measure of power? (The first engines were compared to horses in terms of amount of work they could do.)

Extending the lesson:

1. Investigate the use of elephants by the Carthaginian general Hannibal in crossing the Alps to invade Rome.
2. Investigate the use of dolphins in underwater research and spy activities.

GRADE 9, UNIT II, LESSON 1
(Continued)

3. Can you think of an animal which is not a mammal that is used by people to do work? (cormorant used by Japanese fishermen)
4. Draw a picture of yourself with a favorite animal being used as a beast of burden after fuel supplies are all used up.
5. Describe life on a farm before the invention of the tractor.
6. Add to the class energy word vocabulary list.

GRADE 9, UNIT II, LESSON 2

Title: Offshore Oil

Concept: Energy comes in many forms.

Objective: To discover the relationship between crude oil supplies and the search for oil "offshore"

Introducing the lesson:

1. Man has drilled deep into the earth of the continental U.S. Now there is increasing discussion and controversy about offshore oil. Ask: What is offshore oil? (oil in the continental shelf in relatively shallow water)
2. Examine a map which shows the location of the continental shelf along the coasts of the U.S.
3. Find pictures of offshore drilling platforms during construction and in operation.

Developing the lesson:

1. Ask: If there is plenty of oil left as the oil companies say, why are they drilling in the hostile environments of the offshore wells? (North Sea, Arctic, etc.)
2. Look on a map for the Channel Islands off the California coast, scene of recent offshore exploration and drilling.
3. Investigate the dangers of drilling in this area? (The wells are located in a major earthquake zone - the San Andreas Fault.)
4. Investigate the oil well "blowout" which polluted the beaches of Santa Barbara, California, in 1969.

GRADE 9, UNIT II, LESSON 2
(Continued)

5. Locate the Baltimore Canyon area off the Atlantic coast. Then read about recent attempts to find oil and gas there.
6. Investigate the procedures for obtaining a lease from the U.S. Department of the Interior for drilling rights in areas of the continental shelf.
7. Investigate the problems of constructing drilling platforms in deep and stormy offshore areas. Discuss recent disasters. (North Sea; platform collapsed and many people died)

Extending the lesson:

1. Describe the world when there is no more oil to be found.
2. Read oil company reports and advertisements to find evidence of aesthetic or environmental concern (or lack of it).
3. Read about the great oil spill at a Chevron platform in the Gulf of Mexico in 1970 and the Mexican well in 1979.
4. In an oil company advertisement, comedian Bob Hope drives a golf ball off an offshore platform. Draw a picture of yourself using a platform to do your favorite thing.
5. Draw a mural to show the process of offshore drilling.
6. Investigate the effects of drilling platforms on marine life. (Act as artificial reefs; generally thought to be favorable to marine life, although there is some concern about possible long-term effects of spilled oil and other chemicals.)
7. Discuss whether oil companies would be drilling offshore and in the Arctic if there were plenty of domestic supplies which needed only financial incentive (profit) for development.
8. Add to the class energy word list.

Title: Oil From Rocks

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy forms and the natural forces which caused their formation

Introducing the lesson:

1. Ask: Did you ever hear of oil that is not a liquid? (There are two solid forms - oil shale and tar sands.)
2. Collect pictures showing the process of recovery of oil from oil shale rocks.

Developing the lesson:

1. Locate on a map of the U.S. the Green River Formation where Utah, Wyoming, and Colorado meet along the Green River, a tributary of the Colorado River.
2. Find out how oil was bound into the rocks. (caught in clay sediments which were turned into shale by heat and pressure)
3. Describe the oil in shale. (called kerogen, a tar-like material which melts at 450-600 degrees Centigrade, releasing vapors that can be converted to shale oil)
4. Ask: How much oil is there in the Green River Formation? (2 trillion barrels, many times the amount of all the easily available oil in the U.S.)
5. Investigate the processes and the energy required for recovery of oil:
 - a. above ground (energy for mining, crushing, heating, waste disposal)
 - b. in situ (in place in the rocks; heating rock, oil recovery, waste)
6. Investigate the recovery problems with each method. (Above ground - rock has to be mined, crushed, heated, then waste removed. Rocks expand when heated, so amount of waste material is greater than original rock. In situ - rock has to be broken up by pressure, chemical explosives, or a nuclear explosion, then heated to release oil.)
7. Investigate the environmental problems. (Vast quantities of water required could seriously affect already over-committed flow of the Colorado River; waste rock areas impossible to revegetate without water, if at all; area will become a barren wasteland, devoid of wildlife.)

Extending the lesson:

1. Investigate the sale and leasing of oil shale lands by the U.S. Department of the Interior.
2. Ask: Why should the government sell lands containing trillions of barrels of oil to oil companies for a few dollars an acre? (That's what the laws for mining require.)
3. Discuss the pros and cons of encouraging the development of our oil shale reserves. (need versus problems)
4. Ask: Should we destroy a beautiful section of our western mountains so we can continue our oil-spending and energy-wasting spree?
5. What are the alternatives?
6. Investigate plans to recover a similar type oil from the Athabasca Tar Sands in Canada.
7. Draw a picture of yourself around a campfire lined with oil shale rocks.
8. Add to the class energy vocabulary list.

Title: Refining Oil

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between the various kinds of fuels and their production

Introducing the lesson:

1. In oil company reports or publications, find a picture or chart showing the process of refining oil.
2. Have the students make a large mural on the chalkboard or on butcher paper which shows how a refinery operates.

Developing the lesson:

1. Ask: What does refining mean? (to make better by removing impurities)
2. Investigate the differences in crude oils. (More or less light or heavy; high or low sulphur content. For example, in Florida, Jay oil is a much better grade than Big Cypress oil.)
3. Identify the major components of an oil refinery and give the function of each.
 - a. still or distillation tower - breaks up crude oil into its many chemical components; separates heavy oil from light oil - light oil goes to the top;
 - b. catalytic reformer - rearranges molecules of naphtha into high octane gasoline;
 - c. Polymerization plant - converts light oils from top of still to gas and high octane gasoline;
 - d. catalytic (cat) cracker - breaks down heavy oil fractions to lighter fractions;
 - e. gasoline blending tanks - mix "cracked" gasolines into motor fuel; with these, they increase the amount of gasoline per barrel of crude oil.
4. Ask: What happens to the heavy oils left over after gasoline has been made? (Are made into kerosene, jet fuel, diesel fuel, heating oil, lubricants, and residuals. What's left over then becomes power plant fuels, asphalt, waxes.)
5. What is the major use of energy in refining oil? (fuels to heat the still; refineries use about 10% of their fuel in the refining process)

GRADE 9, UNIT III, LESSON 1
(Continued)

6. Discuss how the conflict between use of crude oils for running our society and use for synthetics and chemicals can be resolved. (Both uses are growing rapidly.)

Extending the lesson:

1. Locate the oil refineries in the U.S.A.
2. Investigate the environmental objections to the siting of oil refineries along coasts. (spills; need coasts for recreation)
3. Why not locate refineries inland? (Nearly all oil is imported, brought in ships.)
4. Discuss demands on various products from the oil refineries. (All demands are increasing and conflicting - gasoline or diesel - or heating oil - or synthetics.)
5. Where will it all end? (Did the strike of truckers in 1979 give us a clue? There will have to be realization that unrestricted growth cannot continue, even if we can harness the free energy of the sun, and that will be expensive.)
6. Draw a picture of your community after an oil refinery is built there.
7. Discuss whether you would object to the siting of an oil refinery in your community.
8. Where would you locate it? (It has to be in somebody's community.)
9. How would you decide?
10. Add to the class energy vocabulary list.

Title: Appropriate Technology

Concept: Energy can be changed from one form to another.

Objective: To discover the relationships between energy in its various forms

Introducing the lesson:

1. Ask: What does the term "appropriate technology" mean? (A term used by the U.S. Department of Energy to describe small-scale energy-related technologies which are "appropriate" or adapted to local needs, skills, and available energy resources.)
2. Discuss what appropriate technology might mean in Florida. (solar, wind, uses which enhance energy conservation, uses of existing technology)

Developing the lesson:

1. Congress authorized a small grants program to encourage development of appropriate technology. Ask: What would be the goals of such a program?
2. Write to the Department of Energy, Southeast Region, 1655 Peachtree Street, N.E., Atlanta, Georgia, 30309, for information on this small grants program.
3. Investigate the concept of "Total Energy" installation of power systems for schools and small communities. (see Clark, page 234)
4. Investigate problems with such installations. (Custom design and construction make them expensive; not as convenient as just turning on the power from utility.)
5. Investigate the number of solar-heated swimming pools in your community.
6. Is solar heating of water or space being used in your school? If not, why not?

Extending the lesson:

1. Design a class mural showing your community with a total energy power installation and solar collectors on every building.
2. Discuss the value of use of renewable resources such as solar energy and wind. (No supply problem - fuel is free after installation costs are paid.)

GRADE 9, UNIT III, LESSON 2
(Continued)

3. Describe the effects on a community of a "total energy" program. (encourages cooperation and self reliance)
4. Design a plan which would make appropriate technology easier to adapt to local needs, skills, and energy availability.
5. Find out the number of days your community had winds strong enough to operate windmills.
6. Add to the class energy vocabulary list.
7. Go on to the next lesson to learn about another appropriate and energy saving technology.

GRADE 9, UNIT III, LESSON 3

Title: Garbage Power

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between energy and matter in organic materials

Introducing the lesson:

1. How to get rid of our mountains of garbage has become an increasingly difficult problem for every community. Ask: How does our community dispose of its wastes?
2. Why don't we burn our organic wastes to produce power?

Developing the lesson:

1. Investigate the formation of methane. Why is it called natural gas? (Organic wastes, dead materials, are fermented by anerobic bacteria and grow in the absence of oxygen to form methane and carbon dioxide.)
2. Ask: Why cannot people use this age-old natural method to dispose of their organic wastes? (too many people and mountains of waste)
3. Find out how much waste is generated in your community.
4. Read about the work of Dr. Ram Bux Singh in designing and construction of "Biogas" plants in India.

GRADE 9, UNIT III, LESSON 3
(Continued)

5. Investigate problems of using sewage effluent from a community in a biogas plant. (too much water, which reduces efficiency of the digester)
6. Discuss how use of cow manure from cattle feed lots in biogas plants could reduce water pollution and waste of a valuable resource. (Kaplan project in Bartow, Florida)
7. Read about the research of Dr. Martin Wolf of the University of Pennsylvania in converting urban wastes to methane. (Clark, page 457)

Extending the lesson:

1. Investigate whether or not your community sewage disposal system uses an anerobic bacteria process. If so, is the methane produced used to power the plant?
2. Investigate the supply problems of a biogas plant. (Major problem is transportation of wastes to the biogas plant.)
3. Consider the environmental costs of using animal manure for biogas production. (loss of valuable soil conditioner and fertilizer)
4. Compare energy production of leaves or grass with manure. (Leaves generate 7 times as much methane. Remember entropy - the cow used most of the energy in the grass to make meat, so not much left in the manure.)
5. Design a methane generator for your home.
6. Investigate the problems with a biogas plant. (Waste is sludge, undigested material, which may make up 40% of the total fuel. Disposal is a problem unless it is used as a fertilizer or soil conditioner.)
7. Add to the class energy word list.

Title: Light

Concept: The earth receives radiant energy from the sun.

Objective: To discover the relationship between the light of the sun and how people see it

Introducing the lesson:

1. Ask: What is light? (a form of the radiant energy of the sun, measured in wave lengths)
2. Have the students describe the light of the sun.
3. Ask: What does it mean to you? (Write their answers on the chalkboard - brightness, shade, blending of colors, etc.)

Developing the lesson:

1. Investigate the use of lenses and other optical glassware to study light through the ages.
2. Focus lights covered with red, blue, and green lenses or cellophane on the top of a white cue ball or egg. Describe the colors you see. (spectrum)
3. Now focus the lights on a large sheet of white paper lying flat on the floor, so that the colors overlap in the center. Note the color white where the red, blue, and green light overlap. Ask: What is white? (sum of all colors)
4. Note where only two colors overlap. Describe the color you see. (red-green overlap = yellow light; red-blue overlap = magenta light; blue-green overlap = cyan)
5. Try to produce the same colors, using artists paints. Do you get the same colors when you mix pigments? (no)
6. Look through a prism to see the colors of the spectrum.
7. Ask: How else might we see the spectrum? (rainbow or looking through a drop of water)
8. Investigate the bending of light as it passes through a lens or water. Look at half of a friend's face through a glass of water. What happened to the light? (Different colors are bent by different amounts and so they spread out to show their colors.)

GRADE 9, UNIT IV, LESSON 1
(Continued)

Extending the lesson:

1. What is the color green we see? (green pigment, which absorbs all the colors of white light except green)
2. What is black? (pigment which absorbs all white light)
3. What is white? (pigment which reflects light and absorbs none or very little color at all)
4. Investigate the reverse colors of a photographic negative.
5. Add to the class energy vocabulary list.

GRADE 9, UNIT IV, LESSON 2

Title: The Tides

Concept: The sun is the chief source of the earth's radiant energy.

Objective: To discover the relationship between total energy and the production of electricity

Introducing the lesson:

1. People of all ages have known of the power of the tides; only the French and Russians have succeeded in developing tidal power plants. Ask: Why do you think there has been so much controversy about building tidal power plants? (require a dam completely across a bay and very expensive)
2. Draw on the chalkboard a diagram of a tidal power plant: large bay, dam across the mouth, ocean outside.

Developing the lesson:

1. Draw arrows to show what happens at high tide. (Water flows through turbines in gates as it rushes into the closed bay.)
2. Now show arrows to indicate flow at low tide. (The flow is reversed, water flows out through turbines, now also reversed, to the ocean.)
3. Ask: What happens when tides are changing? (After high tide, gates are closed to keep water in until the ocean level lowers; then opened to turn generator again. After water flows out at low tide, gates are closed until the ocean rises again. This difference between levels in the ocean and the enclosed bay is called the "head of water.")

GRADE 9, UNIT IV, LESSON 2
(Continued)

4. Could tidal power plants be operated in Florida? (No, because they require tidal level differences of over 40 feet. There are only 15 locations in the world where tidal plants would be possible and only two of them are in the U.S., Passamaquoddy Bay in Maine and Cook Inlet in Alaska.)
5. Investigate the construction of the French tidal power station in the LaRance estuary in Brittany, France, which uses water from the English Channel.
6. What provisions have been made for ships to enter the port of San Malo? (Locks are used for passage of ships.)

Extending the lesson:

1. Investigate the disadvantages of tidal power. (dam across the bay; power lines; possible damage to marine life)
2. Discuss how rising costs of fossil fuels and demands for electricity may make tidal power plants economically feasible.
3. Environmentalists in New England have been protesting against a huge nuclear power plant in New Hampshire. Discuss relative values of nuclear and tidal power plants, assuming enough electricity to supply demand could be produced with tidal power.
4. Add to the class energy vocabulary list.

GRADE 9, UNIT IV, LESSON 3

Title: Solar Electricity

Concept: The radiant energy of the sun can be used directly.

Objective: To discover the relationship between the sun's energy and its use for power

Introducing the lesson:

1. Without the development of solar cells for power, the space vehicles and satellites could not have been operated. What are solar cells? (Solar cells are tiny slices, wafers, of silicon, about $1\frac{1}{2}$ inches square and only a few thousandths of an inch thick.)
2. Solar cells are called "photovoltaic cells." What does photovoltaic mean? (photo = light; voltaic = electricity; named after Alessandro Volta)

Extending the lesson:

1. Investigate possible development of solar power plants on earth. (For the immediate future, it looks like a choice of nuclear and coal for fuel, until the various solar technologies can be made economically feasible.)
2. Ask: Why would a solar cell power plant be more efficient in space? (could be positioned to receive sun's rays 24 hours a day; no loss of solar radiation by reflection from clouds and atmosphere)
3. Review the proposal for a solar farm. (lesson 1, Unit I)
4. Add to the class energy vocabulary list.

Title: Changing Life Patterns

Concept: Lifestyles of people are determined by their use of energy.

Objective: To discover the relationship between the lifestyles of people and the amount of energy available for their use

Introducing the lesson:

1. Ask the students to list ways the energy shortage has affected their lives.
2. Make a class list of changes in lifestyle brought about by the energy shortage and the high cost of energy.

Developing the lesson:

1. On the basis of the class list, discuss which energy shortage or use seems to be the one most closely associated with their lives. (probably gasoline for the family automobile)
2. Discuss whether the energy shortage has really changed the standard of living of people. (only a change in wasteful habits such as driving to the store for a single item they forgot. U.S. living standards are still climbing - latest tallies for automobiles, appliances, furniture and other durable goods total \$1.35 trillion - \$6238 for every person in the U.S. That's a 47% increase since 1970.)
3. Ask the class to describe the American lifestyle. Are we greedy, selfish, lazy, thrifty, spoiled, whatever?
4. Discuss the relationship between lifestyle and standard of living. (how we live versus level at which you live - you may enjoy a high standard of living and be very frugal)
5. Is there a relationship between standard of living and energy use? (Definitely; energy is the essential element.)

Extending the lesson:

1. Go out and find examples of how people's use and the supply of energy affects their standard of living:
 - a. transportation - bicycle or gas guzzler?
 - b. diet - soup and crackers or steak?
 - c. lifestyle - in debt or saving?
 - d. occupations - unskilled or professional?

GRADE 9, UNIT V, LESSON 1
(Continued)

- e. recreation - rowboat or cabin cruiser?
- f. agriculture - family farm or agri-business?
- 2. Suggest ways to reduce use of energy in each example.
- 3. How does people's use of energy reflect their values?
- 4. Discuss the validity of the statement: Energy shortages cause changes in societies.
- 5. How about effect on individuals?
- 6. Has the energy shortage affected your community's standard of living? or only its habits?
- 7. Add to the class energy vocabulary list.

GRADE 9, UNIT V, LESSON 2

Title: My Energy Use

Concept: People use energy to satisfy their needs.

Objective: To discover the relationship between energy use and our daily lives

Introducing the lesson:

- 1. Ask each student to keep a list of things they did during a week which required energy.
- 2. For each activity listed, list the kind of energy used and the duration of the energy use; for example, electricity to toast bread - 2 minutes.
- 3. List the major categories of energy use for the class. (food preparation, beauty, etc.)

Developing the lesson:

- 1. Compare the total energy use by individuals in the class.
- 2. Why is there such a difference among individuals? (Lifestyles differ.)
- 3. Find examples of energy use that seem unusual. (operated a laser beam, movie projector, etc.)

GRADE 9, UNIT V, LESSON 2
(Continued)

4. What do these tell us about the individual's use of energy? (using energy for more than needs)
5. Have each student use both the personal and class lists to design an individual energy conservation plan.
6. Put your energy conservation plan into action.

Extending the lesson:

1. Now make another one-week survey of energy use.
2. Was there any saving of energy as compared to the first survey?
3. Discuss what seem to be the best ways to save energy.
4. Draw pictures of your individual lifestyle before and after implementing your energy conservation plan.
5. Add to the class energy vocabulary list.

GRADE 9, UNIT V, LESSON 3

Title: Developing Nations Want More

Concept: People need energy to raise their standard of living.

Objective: To discover the relationship between a nation's energy use and its standard of living

Introducing the lesson:

1. Review lesson 1, Unit II, on changing life patterns and the relationship between energy use and standard of living.
2. Find pictures of the "barrios" or slum communities on the outskirts of major Central and South American cities. (Caracas, Mexico City, Bogota, etc.)

Developing the lesson:

1. At the U.N. Conference on the Human Environment in Stockholm in 1972, the developing nations insisted on consideration of the problems of the poor in getting food, water, and their needs for life from the environment - not the pollution and energy problems of industrial nations. Discuss the worth of this proposal.

GRADE 9, UNIT V, LESSON 3
(Continued)

2. Ask: Is this a valid concern?
3. Delegates from poor nations said: "We would love to have your level of pollution and the good life it represents." Ask: Why do the poor nations of the world equate energy use, pollution, industrial development, and the "good life"?
4. What should be the response of the U.S. delegate to the conference?
5. What was the response of the U.S. delegation? (The problems of people had to be discussed at "satellite meetings," not on the official agenda.)
6. Ask: Why should a hungry person be concerned about individual and national use of energy and pollution?

Extending the lesson:

1. Discuss the validity of the claims of the developing nations to a greater share of the world's energy resources. (Most of these resources are in underdeveloped nations. In the past, U.S. and European oil and mining companies have exploited these resources and kept these oil and mineral-rich nations poor.)
2. How could this have happened? (Nations with the resources did not have the technology to develop their own resources. Also, the small amounts paid for oil seemed like a lot to "poor" nations.)
3. Discuss how the demands of the developing nations for a greater share of the energy (including dollars) are related to the energy "crisis."
4. Consider other contributing factors. (Middle East conflicts, international politics)
5. Add to the class energy vocabulary list.

Title: Limits To Growth

Concept: Future energy supplies are limited because of present and past waste of resources.

Objective: To discover the relationship between past energy use and future energy supplies

Introducing the lesson:

1. In a controversial book published in 1972, Limits To Growth, the Club of Rome named 5 factors that limit or determine growth of all kinds on the earth: population, industrial production, agriculture, natural resource development, and pollution. They warned that growth in each was doubling in short periods of time; for example, use of electricity is doubling every 7 years.
2. Ask: Is there a limit to growth? (Yes, as all agree. But, there is considerable debate over how growth will end and when.)

Developing the lesson:

1. Read the following French children's riddle, which concerns a pond, a farmer, and a water lily:

"The lily is doubling in size every day. In 30 days, it will cover the entire pond, killing all the creatures living in it. The farmer does not want that to happen; but being busy with other chores, he decides to postpone cutting back the plant until it covers half the pond. The question is: On what day will the lily cover half the pond?" The answer is: On the 29th day; leaving the farmer only one day to save his pond.

2. Ask: Are we now in our 29th day? (During the gasoline shortages of 1973 and 1979, it looked that way.)
3. What really determines the limits to growth? (Energy. Every new discovery of an energy source has increased all five factors in the "Limits To Growth" study.)
4. What happens when industrial output grows faster than population? (Standard of living rises; more products for each person.)
5. Discuss how this has affected the development of societies.
6. What happens if world population doubles and agricultural production does not? (Many people are hungry, as we now have.)

GRADE 9, UNIT VI, LESSON 1
(Continued)

Extending the lesson:

1. Consider how the five factors are related. (For example, we worried about pollution, so we redesigned engines and added emission control devices; this increased gasoline consumption and created a fuel shortage, which led to international political problems - all in a few years.)
2. Have the class develop more chains of related events, such as medical advances or high-rise buildings.
3. What can we learn from these examples? (No one problem can be considered alone. Problems are all related and a change in any one affects all the others.)
4. Do we want science and technology to remove all the limits to growth? (That is the question, even if they could.)
5. Add to the class energy vocabulary list.

GRADE 9, UNIT VI, LESSON 2

Title: Peak Power

Concept: Power supply capacity is based on peak demand for electricity.

Objective: To discover the relationship between electric power production and people's demand for electricity

Introducing the lesson:

1. During a typical summer day in Florida, demand for electric power from the state's electric utilities at mid-afternoon and early evening is more than double the demand at 5:00 a.m. Ask: What effect does this have on the generating capacity of Florida's electric power plants? (They must plan to meet maximum demand.)
2. What is "peak power"? (The maximum demand made on a utility.)

Developing the lesson:

1. Discuss why the demand for electricity would reach a peak at mid-afternoon or early evening. (air conditioners, cooking dinners, TV, etc.)
2. Discuss other times when peak power might be needed. (breakfast and hot shower time; TV prime time, etc.)

GRADE 9, UNIT VI, LESSON 2
(Continued)

3. Discuss the effect of peak power demand on utility company planning. (They must plan for maximum demand even if plant operates at only half capacity most of the time.)
4. How does this affect the number and size of electric power plants? (need more or larger plants)
5. Consolidated Edison Company in New York City, in order to redistribute demand on the company facilities, has conducted an experiment to see what happens when customers are charged according to the time of day they use electricity. Under the plan, customers would pay $2\frac{1}{2}$ times more for electricity during peak hours, less than average for use during off hours. Discuss the following questions:
 - a. How would this plan reduce the need for more generating capacity and hold down costs to customers?
 - b. What could you do to save electricity under such a plan?
 - c. Would you use your washer, dryer, and dishwasher only during off hours to save electricity (money)?
 - d. What problems would this plan involve? (Metering would be difficult and expensive.)

Extending the lesson:

1. Consider how you could save with appliances; their purchase, use, and maintenance. (efficiency)
2. Consider lights, water heaters, refrigerators, stoves.
3. Describe your life if you were limited to 1000 watts of electricity at any one time during the day. Which appliances would you use? Rate them according to your priorities.
4. Could you get by with fewer appliances?
5. Would you prefer an occasional blackout or brownout to having a new power plant built in your community?
6. Compare your list of appliances with those available to your parents when they were your age. Your grandparents.
7. Add to the class energy vocabulary list.

Title: Locating Energy Industries

Concept: Everyone wants power plants for producing electricity, but not in their community.

Objective: To discover the relationship between people's values and locating new power plants

Introducing the lesson:

1. Discuss the following scenario: An electric utility company proposes the construction of a new generating plant in our community. It will be located on the river so the hot water from the plant (condensed steam) can be released into the river. The plant will be large enough to supply 1000 megawatts.
2. Ask for a class reaction to the proposal.

Developing the lesson:

1. Make a list of the advantages and disadvantages of this siting proposal.
2. Discuss the advantages. (economy, jobs, etc.)
3. Discuss the disadvantages. (pollution, transmission lines, supply vehicles through town, etc.)
4. Investigate whether people in communities which encourage siting of utility plants there get lower rates for electricity. (no)
5. Should they?
6. Discuss whether the community reaction would be different if the proposed plant was to be nuclear fueled.
7. Compare the environmental problems of coal or nuclear fuel. Consider:
 - a. mining;
 - b. transportation;
 - c. use; and
 - d. waste disposal.
8. Compare loss of life in coal-related and nuclear-related occupations. (both hazardous for miners)

Extending the lesson:

1. In 1950, the Atomic Energy Commission predicted that the development of nuclear power would produce electricity that would be "too cheap to meter." Ask: What happened to this prediction?
2. Investigate how the public's fear of atomic energy as a result of the nuclear bombs has been exploited by the anti-nuclear lobby in the world.
3. Discuss the effect of the Three-Mile Island nuclear plant accident in Pennsylvania on the future development of nuclear power plants and their locations.
4. With oil in short supply, the nation faces a choice of coal or nuclear fuel for electric power plants. Which will it be?
5. Debate the issues.
6. Add to the class energy vocabulary list.

Title: What Is Safe?

Concept: The search for energy, its use, and its wastes may cause undesirable environmental effects.

Objective: To discover the relationship between environmental quality and the disposal of the wastes of energy production and use

Introducing the lesson:

1. In the 1970 report of the Council on Environmental Quality, then President Richard Nixon said: "Unless we arrest the degradations that have been inflicted so carelessly on our natural systems - which exist in an intricate set of balances - we face the prospect of ecological disaster."
2. What did President Nixon mean by "degradations" and "ecological disaster"? (strip mining, oil spills, loss of environmental quality)

Developing the lesson:

1. Relate these remarks to the perceived and predicted results of the search for and use of energy.
2. Ask: In terms of the waste products of our energy use, what is safe? (How much pollution, radiation, etc. can the environment and people stand?)
3. Describe an environment fit for life and fit for living.
4. Discuss the validity of the following statement: In our society, growth is made possible by the availability of cheap energy.
5. Investigate how we have lowered our national and state standards for air and water quality in order to provide cheap energy. (Air pollution standards were lowered to allow burning of polluting high sulphur fuels in power plants.)
6. Investigate the laws and regulations to increase mine safety and the health of miners.
7. Investigate problems of uranium miners and military personnel exposed to nuclear radiation in testing without safeguards for exposure.
8. Investigate regulations designed to make safer the transportation of highly-explosive or harmful cargoes of trains and trucks, such as liquified natural gas - LNG.
9. Why are spills of liquified gases so dangerous? (When released from container they expand rapidly into flammable gases.)

Extending the lesson:

1. Investigate the efforts to make automobile emissions "safer" for those who live in cities.
2. Draw a picture of yourself in a safe environment.
3. Describe your picture.
4. Discuss how one decides what is safe when the results of exposure to unsafe environments may not appear for years. (Soldiers and miners exposed to radiation in nuclear mining and testing 40 years ago are only now being studied as their cancer rates rose dramatically.)
5. Investigate the effects on people of:
 - a. mercury
 - b. lead
 - c. nuclear radiation
 - d. asbestos
 - e. chlorine gas
 - f. sulphur dioxide
 - g. carbon monoxide
 - h. others
6. Add to the class energy vocabulary list.

Title: "Trade-Offs"

Concept: Living things are interdependent with their environment.

Objective: To discover the relationship between energy supply and use and the quality of the environment

Introducing the lesson:

1. One frequently reads about "trade-offs" to describe the apparent compromises made between environmentalists and developers, industrialists, etc. Ask: What is a trade-off? (I'll give up one of my demands if you will give up a demand of yours.)
2. Make a list of trade-offs that have occurred in your community.

Developing the lesson:

1. Propose for discussion a situation in which an oil company wishes to explore for oil in the Ocala National Forest. Environmentalists try to stop the exploration on the grounds of destruction of timber and wildlife habitat.
2. Divide the class into two groups - environmentalists and oil company representatives.
3. Have the two groups choose a forest supervisor to arbitrate the discussion.
4. Have each of the groups meet to prepare their case for presentation. (pictures, speeches, charts, whatever)
5. Call a meeting of the two groups with the forest supervisor.
6. Let each group give its presentation.
7. Follow this with a question-answer period.
8. Let groups meet to discuss any compromises they might suggest or be willing to accept.
9. Let the company make their proposal for trade-off first, followed by the environmental group.
10. See if a trade-off can be arranged.

Extending the lesson:

1. What is the basic reality in a trade-off? (Neither side is completely happy because they gave up something they wanted.)

GRADE 9, UNIT VII, LESSON 2
(Continued)

2. Investigate trade-offs in the construction of Disney World and other major developments.
3. Investigate environmental battles that have or are being fought in Florida against industry expansion, power plant siting, Miami jet-port, Cross-Florida Barge Canal, Everglades National Park water supply, mining in Ocala National Forest, mining near Suwannee River, etc.
4. Were there trade-offs in those issues which have been settled?
5. Add to the class energy vocabulary list.

GRADE 9, UNIT VII, LESSON 3

Title: Energy And Civilization

Concept: Energy is an important element in the development of a civilization.

Objective: To discover the relationship between energy and the development of civilizations

Introducing the lesson:

1. Ask the students how the availability of energy has affected the development of our civilizations.
2. List the ways energy has influenced our development as a rich and powerful nation.

Developing the lesson:

1. Trace the influence on the development of civilizations of:
 - a. water wheel
 - b. windmill
 - c. sail
 - d. fire
 - e. plant breeding
 - f. steam engine

GRADE 9, UNIT VII, LESSON 3
(Continued)

- g. oil
 - h. slave labor
 - i. internal combustion engine
 - j. airplane
 - k. nuclear fission
2. Investigate the role of energy in the rise and fall of former civilizations.
 3. Predict the role of energy in our civilization in the future.
 4. List the possible new sources of energy or inventions which will enable us to continue the development of our civilization. (solar, nuclear fusion, etc. This could be a good review of all the proposals discussed in these energy lessons.)

Extending the lesson:

1. Predict the effect on western civilization of the loss of any of the following:
 - a. a complete embargo on Arab oil supplies
 - b. refusal of Mexico to sell oil to the U.S.
 - c. a decision to ban the use of nuclear energy
 - d. replacement of fossil fuel energy with human energy
 - e. synthetic products
 - f. supplies of minerals (already critical)
 - g. mechanized agriculture
2. What are we to do to obtain enough energy just to carry on our basic way of life in the U.S.? (a good question!)
3. Add to the class energy vocabulary list.

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Title: Earth's Teakettle

Concept: Energy is the ability to do work.

Objective: To understand the potential use of the earth's heat as an energy source

Introducing the lesson:

1. Show a picture of "Old Faithful" in Yellowstone National Park and discuss this natural marvel. (It is a geyser which builds up a head of steam and erupts, on the average, every 73 minutes.)
2. Ask: Where does this hot water come from? (It comes from a geothermal pool, a subterranean reservoir of hot water heated by the molten interior core of the earth, relatively near the surface.)

Developing the lesson:

1. Investigate the process of producing electricity using geothermal energy. (A series of production wells are drilled to the hot water reservoir from 2,000 to 10,000 feet below the earth's surface; hot water - over 150 degrees C. - flows from the wells to a power plant to turn turbine generators; the cooled water from the power plant is reinjected into the hot underground formation to be reheated and to maintain the reservoir pressure.)
2. Write to Chevron Oil Company for information about their geothermal power plant at Heber, California.
3. Investigate the natural limits to the use of geothermal energy. (Generator must be small because the steam produced is at relatively low pressure; also, wells must be within one mile of the power plant because of heat loss in piping; there are uncertainties about depth, extent of reservoirs, temperature, pressure, and life expectancy of reservoirs.)
4. Write to the U.S. Geological Survey, Department of the Interior, for information on the extent of geothermal areas in the United States.
5. Investigate restrictions on use of geothermal energy. (Many of the potential geothermal areas are in national parks and other protected areas.)
6. Investigate the use of volcanic heating. (Mount Hood, Oregon; Los Alamos Scientific Laboratory, New Mexico)

Extending the lesson:

1. Investigate the use of geothermal energy for heating in Iceland, New Zealand, Mexico, Italy, Hungary, Germany.
2. Investigate the environmental problems associated with the use of geothermal energy. (noisy, odorous with hydrogen sulfide gases, water vapors released cause fogging)
3. Investigate the environmental advantages of using geothermal energy. (It does not require dams, pumped storage reservoirs, strip mining, oil transport, waste disposal; no radioactive wastes.)
4. Trace locations of famous mineral baths and hot springs. (Warm Springs, Georgia; Little Rock, Arkansas; Wiesbaden and Baden-Baden, Germany; Bath, England; etc.)
5. Why are hot springs called "mineral baths"? (because of the dissolved minerals in the water)
6. Build a model of a geothermal electric plant.
7. Divide the class into geographic groups (NE, SE, and so forth) and have them investigate the geothermal potential for that area. Then make a composite map of the United States showing their findings.

Title: Heat And Power From Solid Wastes

Concept: It takes energy to get energy.

Objective: To understand the relationship between energy and matter

Introducing the lesson:

1. Ask: Which would you rather have: 3 million tons of garbage (the annual load for Connecticut) or 7 million barrels of oil and 12 billion cubic feet of natural gas? (That's what the late actor John Wayne offered the state of Connecticut in a proposal to take the state's garbage and produce fuels from it by a process called pyrohydrogenation.)

Developing the lesson:

1. Investigate the process of pyrohydrogenation proposed by Wayne's company, the Duke Engineering Company of Irvine, California. (The treatment of solid wastes in a reaction chamber in the absence of oxygen, using hydrogen as the catalyst, to break down the garbage into basic chemical components, and then "cracking" them as in an oil refinery to produce oil, methane, propane, and a char residue that can be used to make briquettes for outdoor cooking.)
2. Ask: Why isn't this being done everywhere? (So far it has been done only in small experimental models to perfect the technology, and it is expensive; but as the price of oil rises and as oil supplies diminish, the costs may be competitive.)
3. Write to the President's Council on Environmental Quality or the U.S. Environmental Protection Agency for other programs to produce fuels from solid wastes.
4. Investigate the use of animal wastes in Florida. (Kaplan Industries in Bartow)
5. Investigate the use of garbage to fuel electric power plants in St. Louis and Nashville. (see Clark in Suggested Readings)
6. Write to the Solid Waste Section, Department of Environmental Regulation, in Tallahassee for information on recovering energy from Florida's solid wastes.

Extending the lesson:

1. Investigate other hydrogenation methods. (See Clark in Suggested Readings - all methods similar; materials heated to 380 degrees C. in the presence of carbon dioxide; within 20 minutes, almost half of the materials are converted to fuel oil of good quality - 15,000 BTU per pound compared to 20,000 BTU per pound for refined fuel oils.)
2. Investigate development of biogas plants in India by Indian scientist Bux Singh. (See Clark In Suggested Readings.)
3. Discuss the environmental advantages of using solid wastes for fuel production. (Many cities and smaller communities are running out of waste disposal sites; it is conservation of a now-wasted resource; a step toward the solutions of both the energy and waste disposal problems; systems are pollution-free.)
4. Discuss the effects of using agricultural products to produce oil, gas, or alcohol. (It takes energy to produce energy and to convert energy to other forms, so these methods cannot replace our dependence on oil.)
5. Discuss the supply problems of recycling garbage for the production of energy.
6. Survey the availability of waste disposal sites in your community.
7. Survey community willingness to separate organic garbage from metal, glass, etc., for biogas production.
8. Write the Regional Planning Council for your area and obtain their data on solid waste and energy.

Title: Enhanced Recovery

Concept: It takes energy to get energy.

Objective: To understand that it takes a lot of energy to get oil out of the ground

Introducing the lesson:

1. Put a towel in a pail of water. Wring it out by squeezing it. Then ask some students to see if more water can be squeezed out of the towel. That is "enhanced recovery." Oil scientists are now trying to squeeze more oil out of old wells.
2. To demonstrate how oil is pushed out of a well by the pressure of the natural gas in solution with it, show how a bottle of soda pop fizzes when the cap is removed.

Developing the lesson:

1. Ask why enhanced recovery of oil is necessary. (Actually, only a small amount - as little as 5 percent - flows out by natural gas pressure, and usually less than 20 percent of the oil can be pumped out of the well - primary recovery.)
2. Show a picture of an oil well "gusher." (Pictures like this cause people to think that oil just flows out of a well.)
3. Explain that getting oil out of the ground is not like taking a liquid like water out of a glass, but is like taking honey out of a honeycomb with a straw.
4. Investigate secondary recovery methods using water or gas injection into the oil reservoir to increase pressure and "enhance" recovery of more oil. (Water pumped down a well displaces oil in rock pore spaces and drives oil toward a producing well.)
5. Discuss the need for enhanced recovery of oil from domestic wells. (Fewer new oil reserves are to be found, and only half of the known reserves in the United States can be tapped by using conventional techniques, at least at current market prices.)
6. Investigate oil company reports about newer enhanced recovery methods being researched.
7. Discuss why the remaining oil will be more difficult to recover. (The oil in "easy" zones has been removed; the remainder is lining pore walls, trapped in water droplets, or shielded in "hard to get at" rock formations.)

Extending the lesson:

1. Investigate the three new methods being tried for enhanced recovery of oil reserves - thermal, chemical flooding, and carbon dioxide miscible.
 - a. thermal - (Remember the honey and the straw; if the honey were heated, it would be easier to take it up with a straw.) steam is pumped into a producing well when oil pressure falls.
 - b. chemical - use of polymers in water to make water "thicker" so it will not flow as easily and will exert more pressure to push more oil to the wells.
 - c. miscible displacement - use of methane gas injection to expand oil and make it "slippery" so it will move through the pores more easily.
2. Ask: When will these expensive enhanced-recovery techniques be used? (When it is economically feasible - when the recovered oil is competitive with imported oil.)

Title: Fuels For The Future

Concept: Energy comes in many forms.

Objective: To understand that there are many forms of energy

Introducing the lesson:

1. Have the students draw a picture of themselves in their homes or in their community the day after fossil fuels run out.
2. Have them describe their picture.

Developing the lesson:

1. Most of the pictures will be pessimistic, some indicating catastrophic conditions, a few optimistic. Discuss the reasons for their optimism or pessimism.
2. Ask: Do any of you foresee a world not much different from today? (Fossil fuels will last for a long time yet, perhaps as long as 100 years in the case of coal.)
3. Do you think 100 years will be long enough for people to develop new fuels?
4. Investigate the possible alternative fuels of the future, for example, fuels for:
 - a. automobiles - alcohol, biogas, hydrogen, even gasoline. (Remember that the original diesel motor was designed to run on powdered coal.)
 - b. electricity - wind, ocean thermal gradients, solar satellites, solar farms, etc.
5. Review the lessons on nuclear energy and synthetic fuels.
6. Investigate the possible role of nuclear fusion as a source of limitless energy.

Extending the lesson:

1. Discuss the reasons why the fuels of the future are not available now. (Because oil was so cheap and available, research and development of other energy sources was done only on a very small scale; much of the technology has been developed in small-scale laboratory models, but putting it to work in plants large enough to meet the demand for energy is still decades away.)

GRADE 10, UNIT II, LESSON 1
(Continued)

2. Why are we so far behind? (Despite warnings that fossil fuels were running out, people continued to believe that supplies would last forever and acted accordingly.)
3. Investigate the environmental problems associated with the development of:
 - a. synthetic fuels from coal;
 - b. nuclear - breeder reactors and fusion;
 - c. oceans - tidal, wave, thermal gradients;
 - d. hydrogen; and
 - e. solar satellites.
4. Discuss the future of the petrochemical industry, an industry based on oil.
5. Discuss how energy technology has enhanced the quality of life Americans have come to expect.
6. Can technology solve our future energy problems?
7. Again have the students draw a picture of themselves in their homes or in their community the day after fossil fuels run out.
8. Compare their pictures with the pictures they drew at the beginning of the lesson.

Title: Offshore Oil

Concept: Energy comes in many forms.

Objective: To understand the potential contribution of offshore areas to the world's oil supplies

Introducing the lesson:

1. Find a magazine advertisement showing Bob Hope driving a golf ball from an offshore well platform in the Gulf of Mexico, or other oil company advertisements showing their activities in offshore oil exploration and development.
2. Make a bulletin board display of offshore oil platforms being transported, constructed, or used in the Gulf of Mexico, North Sea, Baltimore Canyon off the Atlantic coast, Channel Islands, California, Mexico, etc.
3. Ask: After more than 40 years of oil drilling in the Gulf of Mexico, why the furor over offshore oil development off the coasts of the United States? (big oil spills off Santa Barbara, California; blowout and spill of the Ixotec well off the Mexican coast which polluted beaches in Texas; the disasters in the North Sea; and the threat to the major U.S. fishing area off the coast of New England)

Developing the lesson:

1. Discuss why offshore drilling for oil in most areas is different from offshore Gulf states. (Texas and Louisiana already had many years of experience with onshore production, complete with refineries, pipelines, storage tanks, plus a local work force. New areas have none of these - they will all have to be developed in coastal areas, and the work force will have to be imported, with little local benefits.)
2. Compare the water depths in offshore areas. (Gulf of Mexico - mostly less than 100 feet; North Sea - more than 400 feet; Baltimore Canyon - 600 feet; other Atlantic coast areas - up to (or down to) 1,800 feet)
3. Investigate the formation of offshore oil. (Same as onshore areas - When the oil organisms lived, the onshore areas were offshore areas covered by the sea.)
4. Discuss the implications of offshore drilling at depths of more than 400 feet. (Requires production platforms, pipelines to shore, deep-water ports; weather problems; need for onshore facilities for helicopters, storage, and refining.)

GRADE 10, UNIT II, LESSON 2
(Continued)

5. List the factors which determine onshore impact from the offshore drilling and production activities. (size of field; location; physical properties of the oil - light or heavy, high or low sulfur, etc.; water depth; seabed conditions; weather; obstacles to pipelines; location of refineries; environmental regulations; public attitude; and relations between or among operating companies)
6. Discuss how each of these factors might be important.
7. Investigate the leasing procedures of the Bureau of Land Management, Department of the Interior.
8. Investigate the powers of the states to regulate development of onshore facilities for offshore oil under the Coastal Zone Management Act of 1972. (Get copy from your Congressman.)

Extending the lesson:

1. Write to the Conservation Foundation for information on the impacts of offshore oil production on the environment. (1717 Massachusetts Avenue, N.W.; Washington, D.C. 20036)
2. Discuss how your community would react to the discovery of an offshore oil reserve off your favorite coastal place in Florida.
3. Develop a radio or TV commercial supporting or opposing construction of a deepwater port off the coast of Florida.
4. Write an obituary or a birth announcement for a community where offshore oil is stored and refined.
5. Investigate the effects of offshore developments in the North Sea on the lands, water, and people of Norway and Scotland.
6. Survey community feelings about offshore development, deepwater ports, and other developments which might bring more energy to Florida.

Title: Why More Power?

Concept: Energy is the ability to do work.

Objective: To understand the energy requirements for using appliances

Introducing the lesson:

1. Ask the students to make a list of their favorite electric appliances.
2. Check the wattage requirements for each appliance.
3. Ask: Why do we need more and more electric power every year? (increase in energy use per person and overall population increases)

Developing the lesson:

1. Investigate the increase in consumption of electricity in your community during the 1970's.
2. Investigate the estimated power requirements of your electric utility for the next ten years and their plans to meet that estimated demand for electricity.
3. Make a list of the appliances favored by the students, plus a list of the appliances they have at home.
4. Check the appliances on the list which were not available ten years ago. Twenty years ago.
5. How was the work which is done by these appliances done before they became available? (muscle power - brushing teeth and hair, drying hair, etc.)
6. Compare electric power requirements of modern, more sophisticated appliances with their simpler predecessors, such as color versus black-and-white TV.
7. Make a list of appliances which have been made more energy consumptive. (frost-free refrigerators, color TV, self-cleaning ovens (Do they really clean themselves?) The more work done, the more energy it takes to do it.)
8. Why are terms like "frost-free" and "self-cleaning" really misleading? (They all use electricity to do people's work.)

Extending the lesson:

1. Trace the influence of electricity on:
 - a. industry - automation, computers, etc.;
 - b. social patterns - concentration of people in cities;
 - c. education - TV, computers, labs, etc;
 - d. energy distribution - available to all;
 - e. recreation - under the lights; and
 - f. entertainment - drive-in movies, TV, radio, etc.
2. Investigate the work of the Rural Electrification Administration in bringing electricity to rural areas of the United States.
3. Have students write a description of their lives as if they were living in the year 1880.
4. Design a billboard that promotes the reduced use of electricity.
5. Discuss the environmental costs of ever-increasing use of electricity. (need more power plants; more use of nuclear power or increased pollution from use of coal)
6. Design an energy conservation program for yourself and your class that will reduce your use of electricity.
7. Ask your local utility company or the Office of Energy and Environmental Education, Florida Department of Education, Tallahassee, about the availability of the computer "Watt Counter" for use in the classroom. The "Watt Counter" measures the amount of electricity required to operate various appliances and computes the cost of operation.

Title: Synfuels

Concept: Energy can be changed from one form to another.

Objective: To understand how synthetic fuels can be made from coal

Introducing the lesson:

1. Say: On July 15, 1979, after meetings with 135 consultants and advisors, President Carter announced his new energy plan, the main element of which was an \$88 billion Energy Security Corporation development to produce synthetic fuels for America.
2. Ask: What are synfuels? (Oil and natural gas made from other fuel sources - coal, garbage, plant and animal wastes, oil shale and tar sands, etc.)

Developing the lesson:

1. Why are fuels made from natural products "synthetic"? (They are made by chemical reactions in laboratories or factories, not naturally.)
2. Investigate the process for changing coal into natural gas.
3. Investigate the process for changing coal to oil.
4. Set up a laboratory demonstration of the processes.
5. Write to Exxon Corporation for information on their pilot plant for oil production from coal at Baytown, Texas. (If successful, this pilot will provide the basis for the first commercial plant in the United States.)
6. Find evidence of other solid fuels being transformed into synfuels.
7. What is the major problem in synfuel production? (How to get rid of the materials that form ash and the sulfur in the coal, which creates the sulfur oxides of smog and acid rain.)
8. Why is shale oil considered a synfuel? (The actual oil material in shale is kerogen, which changes to crude oil when heated.)
9. How will the costs of synfuels compare with present costs of crude oil? (much more expensive, but costs may become competitive as oil supplies dwindle)

Extending the lesson:

1. Investigate the use of "coal gas" for lighting and heating in the United States in the 18th century.

GRADE 10, UNIT III, LESSON 1
(Continued)

2. Why do oil wells and refineries burn off (flare) gas when it is so scarce and expensive? (This is no longer done in the United States, but in some places there is no market for the gas; this practice will soon be eliminated entirely.)
3. Discuss the reactions of people in places like Montana, where 68 of the proposed synfuel plants would be located to take advantage of western coal supplies. (Consider the use of two tons of water for every ton of fuel produced in the west where water is already scarce.)
4. How are the oil companies protecting themselves from the synfuel business? (They own a large percentage of the coal and have developed most of the small pilot plants to develop the synfuel technology.)
5. Why not use the coal and save all the energy of production of synfuels? (oil and gas much cleaner)
6. How much loss of energy will there be in synfuel production? (U.S. Bureau of Mines estimates a loss of one-third of the energy in the coal.)
7. How much will the synfuel plants cost? (\$1 billion each)
8. Draw a picture of your community after a synfuel plant has been constructed there.

Title: Petrochemicals

Concept: Energy can be changed from one form to another.

Objective: To understand the use of oil to make synthetic products

Introducing the lesson:

1. Ask: What does hairspray have in common with an artificial heart valve? A dishpan with an umbrella? A suitcase with an automobile tire? Pantyhose with a hair dryer? Bubble gum with balloons? (All products are made from or contain new synthetic materials people have made from the chemicals in crude oil.)
2. Make a list of the plastic or synthetic fiber materials students in the class are wearing, using, or carrying.

Developing the lesson:

1. Discuss the validity of this statement: Almost every aspect of our lives is affected by man-made materials made from oil.
2. List the product lines of petrochemicals and give some examples of each. Examples include:
 - a. olefins - basic chemical building blocks, such as ethylene, propylene, butadiene, isobutylene, isoprene;
 - b. aromatics - have a characteristic aroma, as benzene;
 - c. plastics - thousands of products;
 - d. agricultural chemicals - fertilizer;
 - e. additives - STP, etc., to increase octane ratings of gasoline and enhance motor oils;
 - f. synthetic rubber - tires, tubes, hoses;
 - g. plasticizers - chemicals mixed with plastics to soften them, for example, polyvinyl chloride, which can be made into rigid pipes, can be softened enough to make a raincoat by adding a plasticizer;
 - h. fabricated products - asphalt shingles, ceiling tiles, bottles, rope;
 - i. packaging materials - wire insulation, carpet backing; and
 - j. specialty chemicals - coatings, resins, sealants, oil field chemicals, printing inks, oil spill dispersants.

GRADE 10, UNIT III, LESSON 2
(Continued)

3. Ask: Can we afford to use scarce crude oil supplies for petrochemicals? (Yes, but only when they are less energy intensive than renewables or can be converted to other uses; they use only 5 percent of crude oil used in the United States. Some people recommend saving oil for future use for petrochemicals.)

Extending the lesson:

1. Draw a picture of your room at home without products made from petrochemicals.
2. Design a TV commercial to promote saving crude oil for future use for petrochemicals.
3. Describe your life without the appliances made of plastic that you use every day.
4. Discuss possible new uses of plastics. (Increased use of plastics in automobiles reduces weight and increases mileage, etc.)
5. Create a billboard promoting plastic cars.
6. Describe the impact on natural resources if the manufacture of plastics was stopped. (The demand for wood products would increase, which might increase prices. There is not enough wood, rubber, metals, etc., to make all the products now made from plastics.)
7. Start a campaign to recycle plastics in your community. (Most people do not even know that plastics can be recycled and their chemicals used again.)
8. Start your own energy conservation program.
9. Research the use of synthetic fibers for clothing and textiles and the implications of using all natural fibers. Write to the Governor's Energy Office in Tallahassee for brochures.

Title: Wasted Waterpower

Concept: Energy can be changed from one form to another.

Objective: To understand the potential of small dams to supply energy on a local level

Introducing the lesson:

1. Ask a few students or the whole class to sing the famous old song: "Down by the Old Mill Stream."
2. Discuss the origin of the term "mill stream." (A stream on which a dam had been built to provide waterpower or electric power.)
3. Find pictures of dams on small "mill streams."

Developing the lesson:

1. David E. Lilienthal, former chairman of TVA and the Atomic Energy Commission, says that one of our nation's greatest wastes of energy is our failure to use the power available in the water flowing in the rivers of America, at least half of it over existing, but no longer used, dams. Discuss the implications of this statement, even for Florida which has few fast-flowing streams.
2. Investigate the potential for hydro-power in the United States. (A Federal Power Commission study estimated that the United States has 113,000 megawatts of undeveloped hydro-power potential, almost twice as much as the 66,000 megawatts of existing capacity.)
3. Write to the Federal Power Commission for information on present and proposed use of hydro-power. (Washington, D.C.)
4. Discuss why hydro-power potential is becoming attractive again. (It is substantial in volume; more than half is still to be developed; it renews itself; its cost will not rise; it does not pollute the air nor make a violent impact on the environment; it is widely distributed, but not in Florida; and it is available where it is used and needed.)
5. So why are we not using this wasted power? (People tend to think of huge power plants, transmission systems, and do (did?) not consider a 5,000 or 10,000 kilowatt - enough for 5-10 families - plant as practical; that is changing as communities think about becoming energy self-sufficient.)
6. How much additional power could be available from existing sites that are no longer used? (The U.S. Army Corps of Engineers estimates that installation of generating equipment at existing unused sites could add 54,000 megawatts to the nation's power pool.)

GRADE 10, UNIT III, LESSON 3
(Continued)

7. How much savings of oil would this amount to? (The Federal Power Commission study found that if only ten percent of our 50,000 small dams were even partially developed, we could save the energy equivalent of 180 million barrels of oil every year.)

Extending the lesson:

1. Investigate the use of waterpower in New England 150 years ago. (saw mills, cider mills, grist mills, followed by the production of electricity to power woodworking and textile mills. Waterpower made New England predominant in industry.)
2. Compare this with New England today. (Very few dams are in operation and mills are closed, while the energy shortage is both critical and expensive.)
3. Why were the small hydro plants shut down? (Utility companies using coal and oil in central generating plants provided cheap electricity, so the smaller plants closed down as they became less profitable to operate.)
4. Find pictures of small dams, waterwheels, etc., and make a mural of hydro-power in history.
5. Write a new verse about the "New Mill Stream."
6. Design and build a model of a "low head" hydro generating plant.
7. Research the potential for hydroelectrical generation in Florida. (not feasible due to flat topography)

Title: "Ouroboros"

Concept: The sun is the source of the earth's radiant energy.

Objective: To understand the heating effects of solar radiation

Introducing the lesson:

1. Say: The energy of the sun is free. Why don't we use it, especially here in the "Sunshine State"? This is a question we hear more and more these days, so how can we answer it?
2. Ask: Do you think there could be such a thing as autonomous living - a home completely independent from outside energy sources? (It is technologically possible, but its cost may be prohibitive; an experiment at the University of Minnesota may give us some answers.)

Developing the lesson:

1. Investigate the design of the experimental "Ouroboros" house at the University of Minnesota. (It was designed to use simple technologies to achieve self-sufficiency.)
2. What is the purpose of the experiment? (To create a laboratory to use the free energy of nature in place of expensive and dwindling supplies of fossil fuels.)
3. Investigate the three major elements of the laboratory house:
 - a. solar collectors for heating air and water;
 - b. a windmill for generating electricity; and
 - c. an enclosed sewage system for recycling wastes and conserving water.
4. What other features contribute to its designed self-sufficiency? (It has a sod roof; venting system; heavy insulation; orientation and design of house angles for orientation to the rays of the sun.)
5. How do the elements of the system work?
 - a. The sod roof is oriented to the north; cools by evaporation in summer, conserves heat in winter; will last 60 years.
 - b. Solar collectors are of two types being used for comparison; one is an old-style "open trickle"; the other is a new design called an "internal flow" - a steel sandwich in which the water flows between two sheets of lightweight steel, resulting in a complete wetting of the surface and more (three times) efficient heat transfer.

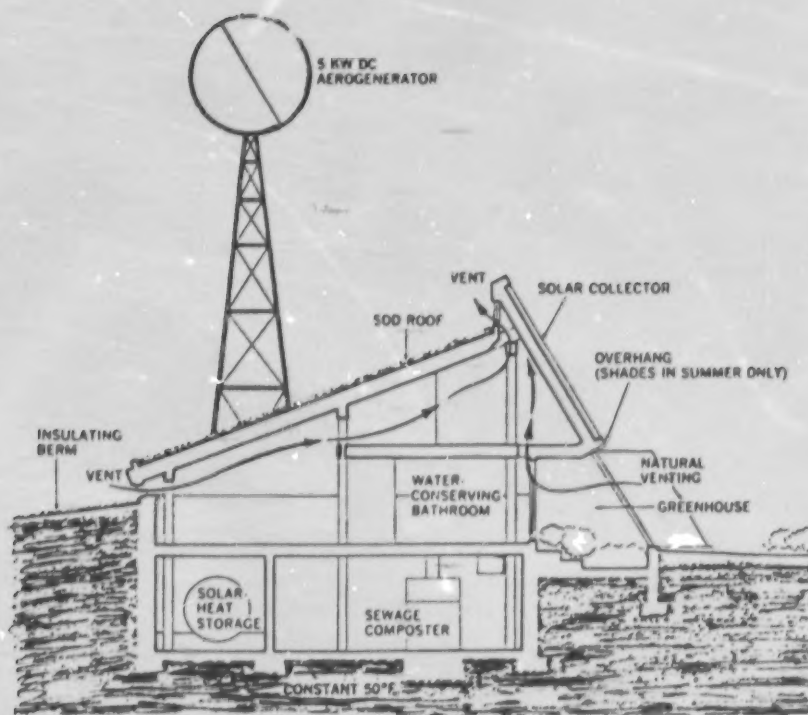
GRADE 10, UNIT IV, LESSON 1
(Continued)

- c. For the ventilation system, winds blowing over the roof bring cool air that collects under the eaves near the ground inside and up through the windows - like an Indian tepee.
- d. The composting toilet allows bathroom and kitchen waste to fall into a box in the basement, where bacteria turn it into a safe, granular, almost odorless fertilizer.

Extending the lesson:

- 1. Ask: What's new? (Nothing except the solar collectors; sod houses, windmills, Japanese baths, composting toilets, insulation, orientation to the sun, and venting are all old practices; even the steel sheet solar collector was patented in 1829, as architect John Ilse found when he applied for a patent on his "invention".)
- 2. Investigate the story of Ouroboros. (A story about a mythical serpent that survived and regenerated itself by eating its own tail and feces, thereby achieving a state of complete self-sufficiency, neither taking from or adding to the environment.)
- 3. Investigate use of solar water heaters in Florida. (In 1951, it was estimated that there were more than 50,000 in Miami alone; the Solar Products Company of Opa Locka made panels called SOLARTEK, 3 by 6 feet, weighing 40 pounds, and easily installed by the purchaser.)
- 4. Ask: What happened to solar water heating in Florida? (Solar systems were replaced by electric systems which the utility companies installed and financed.)
- 5. Design and construct a model of an Ouroboros house for Florida. How will it be different from the experimental house in Minnesota?

OUROBOROS HOUSE



Sloping roof, angled windows, and soaring ceiling give dramatic impact to interior of trapezoid-shaped house.

Ground-level windows open to let in cool air in summer. As air heats it rises and eventually exits at vents at roof behind solar panels. Result: free cooling.

Resourceful bathroom uses closed-cycle toilet, fine-mist shower to minimize water usage, and Japanese-style soaking tub, where pre-cleaned bathers can lounge (together or separately).

Title: Solar Satellites

Concept: The sun is the source of the earth's radiant energy.

Objective: To understand the potential of solar satellites for generating electricity and beaming it to earth

Introducing the lesson:

1. Ask the students for their reaction to the idea of a solar power plant in space. Ask: Could it be done? Why - or why not? (In 1968, Dr. Peter Glaser of the Arthur D. Little Corporation proposed just such a solar power plant in an article in Science magazine. Needless to say, the proposal created a furor in the scientific community.)
2. Have a group of students report on Dr. Glaser's proposal. (Science, Volume 162, Number 3856, November 1968)

Developing the lesson:

1. List the features of the Glaser proposal.
 - a. Electricity produced by silicon cells;
 - b. Electricity transmitted to earth by a giant microwave beam; and
 - c. An enormous space station 22,300 miles from earth.
2. How much power could be produced by the Glaser system? (55 megawatts - the equivalent of five large plants)
3. Why not put the power station on earth? (Even if the sun shone every day, there would be only an average eight hours per day of solar power input; in space, it would be a continuous 24 hours.)
4. What would the system look like? It would have:
 - a. a pair of solar collectors, each 4 kilometers square; wings made of a thin sheet of thousands of interconnected solar cells to convert sunlight to electricity;
 - b. a microwave power converter to convert DC electricity to microwaves;
 - c. a microwave transmitter; and
 - d. a receiver system on earth to convert the microwaves back to electricity.

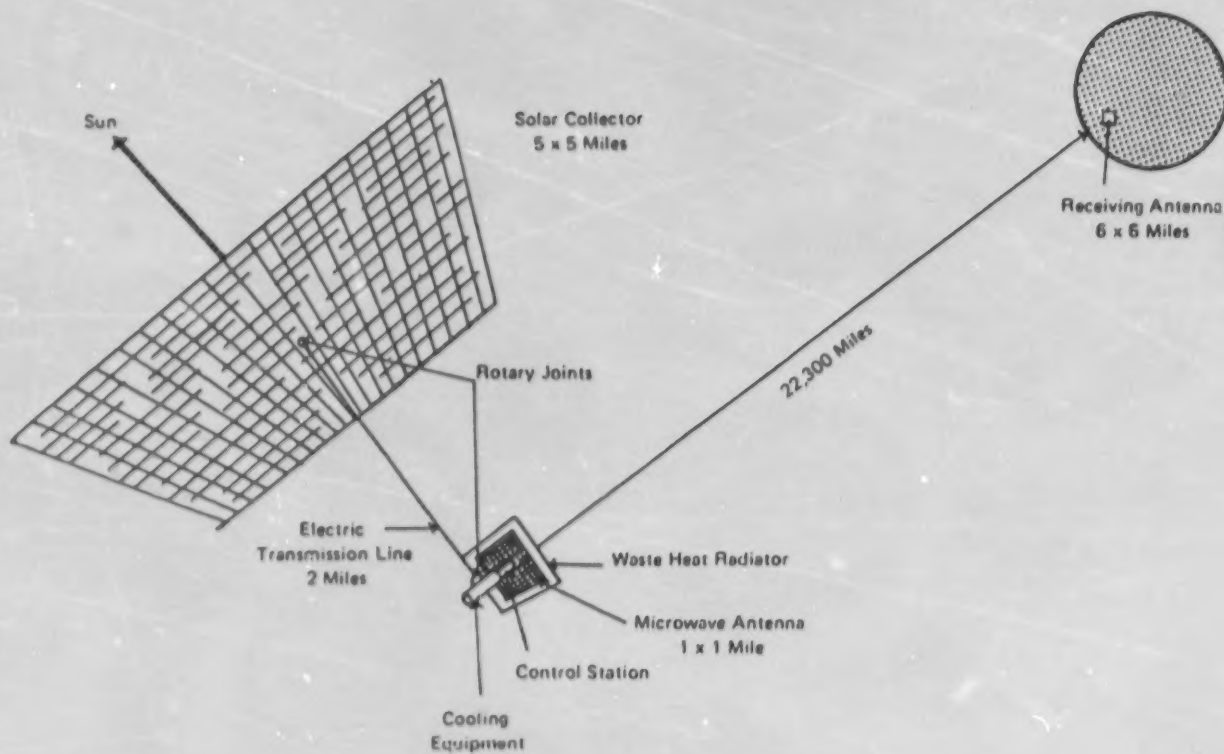
GRADE 10, UNIT IV, LESSON 2
(Continued)

5. Discuss the problems of size and assembly. (The satellite station would be ten times larger than anything yet orbited and would require thousands of rocket flights to the fabrication point for assembly; the solar blanket alone would weigh at least 16 million pounds.)
6. How much would it cost? (It was estimated to cost \$20 million per station in 1968, making the electricity cost ten times its cost at that time.)
7. Estimate the cost of a station today. (Research inflation rate since 1968.)

Extending the lesson:

1. Investigate the advantages of transmitting microwave power from space to earth. (no transmission losses in the space vacuum and very little loss in passing through the earth's atmosphere)
2. What would be the environmental effects? (Criticism has focused on possible dangers of microwave radiation - a relatively unknown pollutant until it was associated with microwave ovens; Dr. Meinel warns that the microwave beam could be a death ray if it accidentally strayed from the receiving antenna.)
3. Write to the U.S. Department of Energy in Washington, D.C., for the estimated cost of a solar satellite station today.

PROPOSED SATELLITE POWER STATION



SOURCE: Peter E. Glaser, Arthur D. Little, Inc.

Title: Power From Thin Air

Concept: The sun is the source of the earth's radiant energy.

Objective: To understand the potential of windmills for producing electricity

Introducing the lesson:

1. Look for the magazine advertisements of the Caterpillar Tractor Company - two men pointing to a windmill, the younger one saying: "The perfect energy - clean, cheap, and it can't foul up the environment." The older man replies: "But it can't meet today's needs." The text of the advertisement: "Too bad about windmills. They just aren't a practical solution to our energy dilemma."
2. Or, the Atlantic Richfield Oil Company advertisement: Scene 1 - windmill turning, lights in houses on; Scene 2 - windmill stops turning, lights go out. Text - "When our fossil fuels are gone, we'll just turn on the windmills. A great idea - until the wind dies down."

Developing the lesson:

1. Discuss the message of these oil companies and coal-mining interests in their advertisements.
2. Why the attacks on windmills and wind power? (Do they represent a threat to the control of energy sources?)
3. Investigate the development of the Jacobs Wind Electric Company in 1928 by Marcellus Jacobs.
4. Investigate the windmills at Grandfather's Mountain in North Carolina and Grandpa's Knob in Vermont.
5. How much energy is available from windmills? (Estimates by the World Meteorological Organization in 1954 predicted 20 billion kilowatts at sites around the world - bald mountain tops, sea cliffs, etc.; in 1970, the Federal Power Commission estimated United States' generating capacity at 330 million kilowatts.)
6. What are the problems with wind power? (Strong winds break the propellers; calm winds shut down the plant.)
7. Investigate the proposals of Professor Heronemus of the University of Massachusetts for a wind-powered electric system off the coast of New England to produce hydrogen fuel. (Audubon, May 1974)

GRADE 10, UNIT IV, LESSON 3
(Continued)

8. What are the environmental problems with wind power? (Visual pollution of windmills on mountain tops or offshore bother environmentalists; effects are small compared to dangers of use of fossil and nuclear fuels.)

Extending the lesson:

1. Find pictures of old windmills and create a mural showing the evolution of windmill design.
2. Discuss the statement by former Secretary of the Interior Stewart Udall: "Windmills are more than relics. They are symbols of sanity in a world that is increasingly hooked on machines with a hunger for fuel and a capacity to pollute."
3. Investigate the history of windmills. (started in Persia in 644 A.D.; brought from Persia to China by Genghis Khan and are still used to pump water in Holland, Denmark, and New England.)
4. What was the effect of James Watts' invention of the steam engine on the use of windmills?
5. What is the wind? (moving air)
6. Investigate the potential of using wind power in Florida for generating electricity. Ask your County Agent for information from the County Energy Handbook or write to the Florida Solar Energy Center, Cape Canaveral, Florida.
7. Build a windmill.

Title: Florida Energy Profiles

Concept: People use energy to supply their needs.

Objective: To understand how people use energy to supply their needs, wants, and dreams

Introducing the lesson:

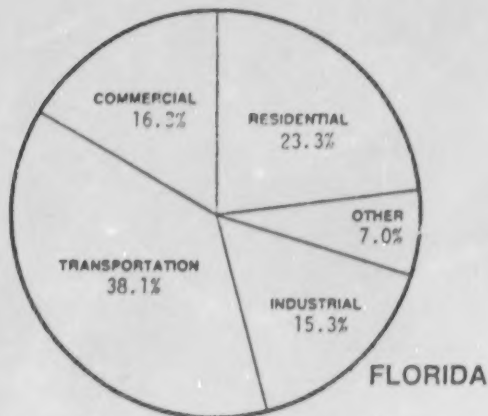
1. Ask the students to make a list of the ways energy is used in Florida.
2. Ask them to rank the uses of energy from highest to lowest.

Developing the lesson:

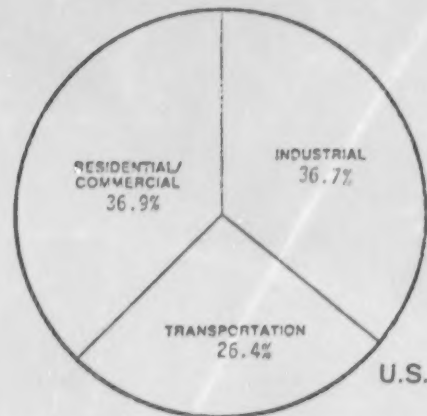
1. Now study the "pie" chart showing the percentages of energy use for each of the major sectors in Florida.
2. Compare the student ranking of energy use sectors with the actual use figures shown in the chart. (transportation, residential, commercial, industrial, and "other")
3. Compare the Florida "pie" with the "pie" for the nation. (Florida uses almost twice as much energy for transportation as for business or commercial uses; residential and commercial about the same as U.S.; industrial use for the nation is more than double that for Florida)
4. Discuss the significance of the high percentage of energy use for transportation in Florida. (Florida is more dependent on gasoline than the rest of the nation.)
5. Compare the percentages of 1978 with the percentages of 1980.
6. Now study the transportation "pie" for Florida. (Over 50 percent of the energy is used by private passenger vehicles; less than 1 percent for buses; most public passenger use of fuel energy is for air travel.)
7. Discuss the implications of these aspects of the Florida energy profile in a future with limited gasoline supplies. (more travel by air and rental vehicles; less private passenger travel; perhaps more rail travel)
8. Discuss the implications for the future of the tourist industry. (less overall use of gasoline; increased air travel, etc.; but the tourists will get here somehow)

FLORIDA ENERGY PROFILES

Total Energy Consumption by Sector, Florida and the United States, 1978

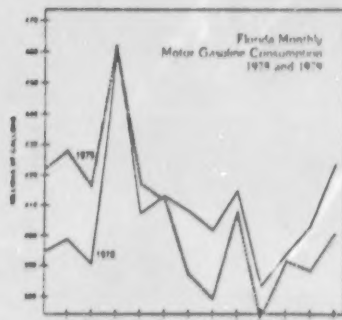


Transportation is the largest energy-consuming sector of the Florida economy. The industrial sector and the commercial sector each consume only half as much energy as transportation, while the residential sector consumes only 60 percent as much. In contrast, the

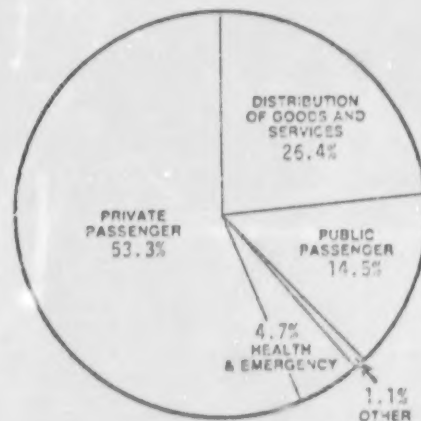


industrial sector is the largest energy consumer of the U.S. economy. Florida is, therefore, relatively more dependent on gasoline than is the nation in general. Factors contributing to this include Florida's large land area, land use patterns, and high degree of travel activity.

Energy Consumed in Transportation in Florida, 1978



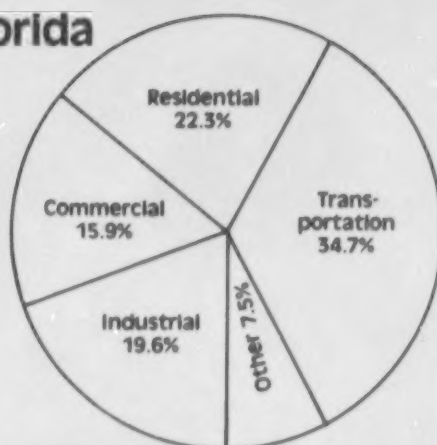
Motor gasoline consumption in Florida was higher during the first four months of 1979 than in the comparable period of 1978. During the shortage situation which occurred in June, 1979 consumption decreased and remained below the 1978 level for the remainder of the year. The largest decrease was in December, with 1979 consumption for the month 5.6 percent below that of December 1978.



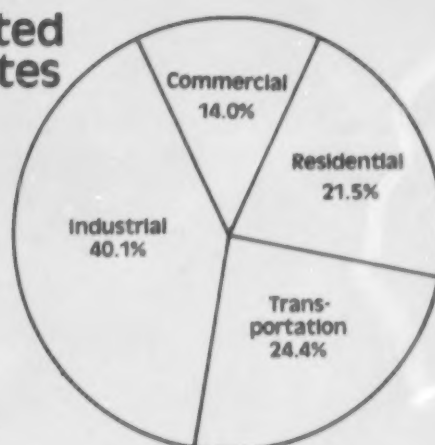
More than half of all energy consumed for transportation in Florida fuels private passenger vehicles. Less than one-fourth of transportation energy consumption is devoted to distribution of goods and services primarily via truck and rail. The bulk of public passenger transport in Florida represents airline traffic; buses account for only 0.7 percent of petroleum use in the transportation sector.

Percentage of Total Energy Consumption by Sector — 1980

Florida



United States



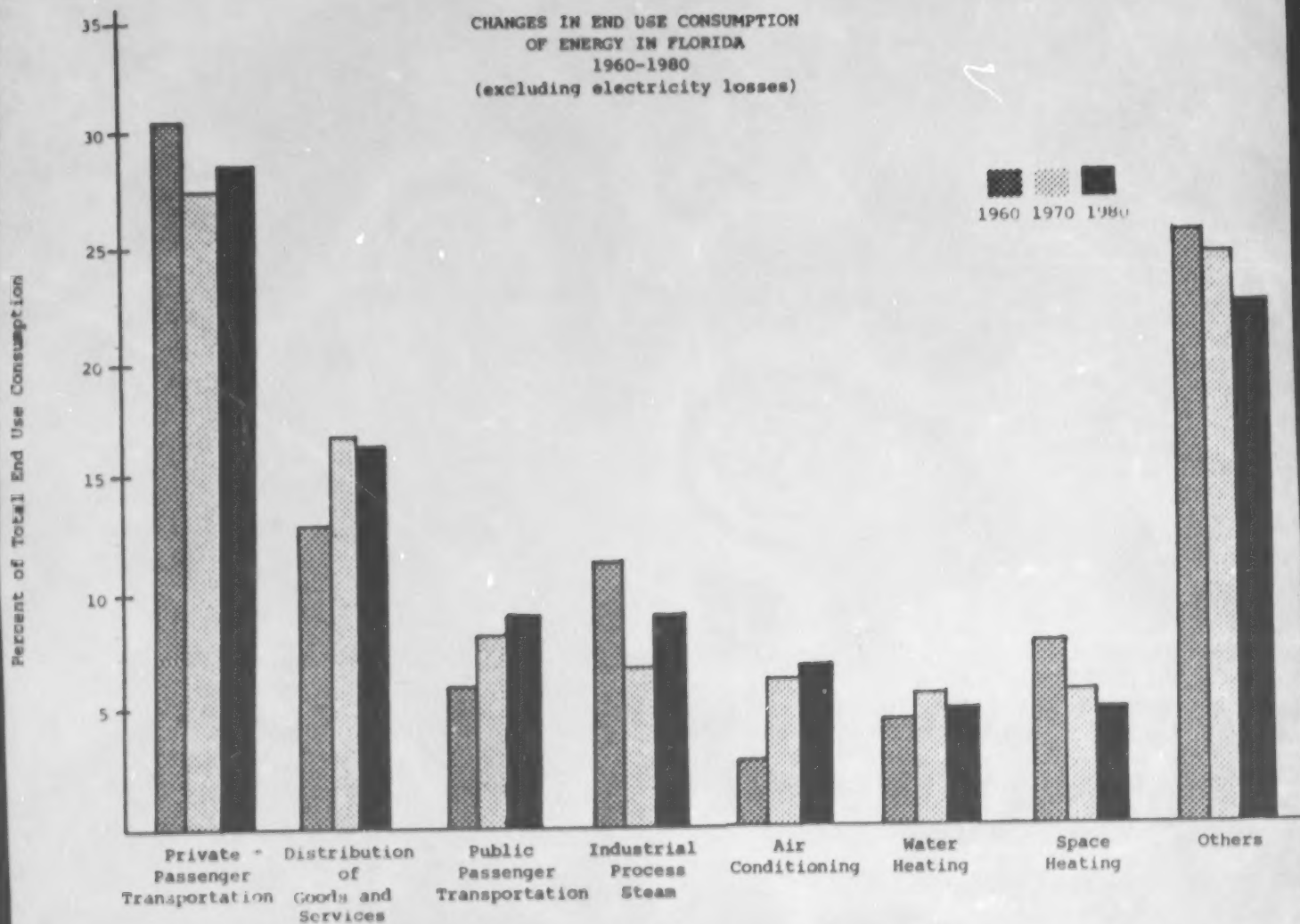
The consumption of energy in Florida differs from that of the country as a whole. The transportation sector is the largest energy consuming sector in the State. In 1980, transportation accounted for 34.7 percent of energy use in Florida, but only 24.4 percent of the nation's. While over 40 percent of the country's total energy consumption was in the industrial sector, industry accounted for less than 20 percent of energy use in Florida.

GRADE 10, UNIT V, LESSON 1
(Continued)

Extending the lesson:

1. Discuss the effects of a gasoline shortage on you and your family.
2. Do the same for the effects on shopping malls, drive-in theaters, fast-food stands, motels, etc., which depend on people who drive automobiles.
3. Ask: What businesses could benefit from a severe shortage of gasoline? (downtown stores and businesses, hotels near airports, local stores, and service businesses)
4. Describe your community with transportation curtailed.
5. Will you like your community better? How will you decide?
6. Design a billboard to promote less use of private passenger vehicles.
7. Study the graph on the next page to compare the changes in end use consumption of energy in Florida.
8. In the total end use of energy in the U.S. the percentages are much higher for space heating (about 60%) and much lower for air-conditioning (about 3%). Discuss the reasons why.
9. Have students write or discuss why they think:
 - a. private passenger transportation dropped in 1970;
 - b. space heating declined between 1960 and 1980;
 - c. public passenger transportation increased;
 - d. air-conditioning increased; and
 - e. other changes occurred.

CHANGES IN END USE CONSUMPTION
OF ENERGY IN FLORIDA
1960-1980
(excluding electricity losses)



Title: Appliance Labeling

Concept: People use energy to satisfy their needs.

Objective: To understand the energy efficiency of appliances

Introducing the lesson:

1. In 1975, the Energy Policy and Conservation Act directed that appliance manufacturers must place labels showing estimated operating costs on all models of appliances and equipment.
2. Write to your Congressman's office for a copy of the Act.

Developing the lesson:

1. What was the purpose of the Act? (to help consumers shop for energy-saving household appliances and equipment as a part of the nation's energy conservation plan)
2. What kinds of appliances and equipment are included under the law? (most household appliances)
3. Investigate how the Department of Energy is implementing the Act. (Write to the Appliance Program Division, Department of Energy, Washington, D.C. 20461.)
4. Examine the Edison Electric Institute chart (on next pages) showing Annual Energy Requirements of Electric Household Appliances.
5. Pick out the big energy users in your home.
6. What is the big energy user in washing clothes? (heating the water - drying clothes)
7. Compare the use of electricity in regular and frost-free refrigerators and freezers.
8. Compare color and black-and-white TV sets, and "instant-on" TV sets with "on-off" sets.

Extending the lesson:

1. Discuss which is best to buy - a cheaper less efficient appliance or a more expensive but more efficient appliance.
2. Have students compute the amount of KWH their home appliances would use in a year, according to the charts.
3. If students can obtain electric bills for a year, have them compute actual amounts of KWH used.

GRADE 10, UNIT V, LESSON 2
(Continued)

4. Discuss the effect of the Act on choosing more efficient appliances. (You can't tell by looking at an appliance if it is efficient or not; under the Act, the manufacturer will have to tell you. Large appliances have Energy Guide labels attached.)
5. Figure out your appliance energy budget, using the chart.
6. Find ways to use less energy.
7. Draw a picture of your life without appliances.
8. Create a TV commercial promoting appliance efficiency.
9. Convert your TV commercial to a poster ad or T-shirt message.
10. Visit appliance stores to compare appliance energy use labels. A slide show and materials concerning appliance labeling are available from the Governor's Energy Office.

APPROXIMATE POWER RATING AND ESTIMATED ANNUAL ENERGY
CONSUMPTION OF ELECTRIC APPLIANCES UNDER NORMAL USE

	Average Wattage	Est. KWH ^(a) Consumed Annually
FOOD PREPARATION		
Blender	386	15
Broiler	1,436	100
Carving Knife	92	8
Coffee Maker	894	106
Deep Fryer	1,448	83
Dishwasher	1,201	363
Egg Cooker	516	14
Frying Pan	1,196	186
Hot Plate	1,257	90
Mixer	127	13
Oven, Microwave (only)	1,450	190
Range		
with Oven	12,200	1,175
with Self-cleaning Oven	12,200	1,205
Roaster	1,333	205
Sandwich Grill	1,161	33
Toaster	1,146	39
Trash Compactor	400	50
Waffle Iron	1,116	22
Waste Disposer	445	30
FOOD PRESERVATION		
Freezer (15 cu ft)	341	1,195
Freezer (frostless 15 cu ft)	440	1,761
Refrigerator (12 cu ft)	241	728
Refrigerator (frostless 12 cu ft)	321	1,217
Refrigerator/Freezer (14 cu ft)	326	1,137
(frostless 14 cu ft)	615	1,829
LAUNDRY		
Clothes Dryer	4,856	993
Iron (hand)	1,008	144
Washing Machine (automatic)	512	103
Washing Machine (non-automatic)	286	76
Water Heater	2,475	4,219
(quick recovery)	4,474	4,811
COMFORT CONDITIONING		
Air Cleaner	50	216
Air Conditioner (room)	860	860*

*Based on 1,000 hours of operation per year. This figure will vary widely depending on area and specific size of unit.

	Average Wattage	Est. KWH ^(a) Consumed Annually
COMFORT CONDITIONING (Cont'd)		
Bed Covering	177	147
Dehumidifier	257	377
Fan (attic)	370	291
Fan (circulating)	88	43
Fan (rollaway)	171	138
Fan (window)	200	170
Heater (portable)	1,322	176
Heating Pad	65	10
Humidifier	177	163
HEALTH AND BEAUTY		
Germicidal Lamp	20	141
Hair Dryer	381	14
Heat Lamp (infrared)	250	13
Shaver	14	1.8
Sun Lamp	279	16
Tooth Brush	7	0.5
Vibrator	40	2
HOME ENTERTAINMENT		
Radio	71	86
Radio/Record Player	109	109
Television		
Black-and-White		
Tube Type	160	350
Solid State	55	120
Color		
Tube Type	300	660
Solid State	200	440
HOUSEWARES		
Clock	2	17
Floor Polisher	305	15
Sewing Machine	75	11
Vacuum Cleaner	630	46

Source: Edison Electric Institute.

(a) KWH = Kilowatt-hour

GRADE 10, UNIT V, LESSON 3

Title: Rapid Transit

Concept: People use energy to satisfy their needs.

Objective: To understand the need for public rapid transit

Introducing the lesson:

1. A Mobil Oil Company advertisement said: "The nation needs to get moving with a Master National Transportation Program. We must stop dealing with highway construction, railroad needs, urban mass-transit, airport improvement, and maritime requirements in separate pieces of legislation - when they are dealt with at all."
2. Ask the students to comment on the validity of this advertisement.

Developing the lesson:

1. Discuss the Florida transit situation. (little railroad service; no rapid transit; few buses; and overcrowded airports. 50 percent of Florida's energy use is for private passenger vehicles.)
2. Why is a master plan most important for Florida? (Florida is extremely vulnerable to any shortage of gasoline; if jet fuel shortages curtailed air travel, Florida would be severely affected.)
3. Have a group of students prepare a report on the personal rapid transit systems (PRT) developed in Morgantown, West Virginia, and (MARTA) in Atlanta, Georgia.
4. How does PRT differ from familiar rapid transit systems? (It is personalized - like taking an elevator; when you press a button in a PRT station, a vehicle is sent automatically to pick you up and deliver you to your destination.)
5. Investigate the use of trolleys and electric buses in the United States.
6. Ask: Why were old trolley systems converted to buses? (A subsidiary of General Motors, named National City Lines, acquired systems all over the United States in the 1940's and 1950's with the intention of changing them over to buses, to provide a market for GM buses - all done in the name of "progress.")
7. Investigate the streetcar systems in Boston, Philadelphia, and Toronto. (They have been expanded and upgraded as preferable alternatives to buses.)
8. Investigate the return of streetcars in Buffalo, Houston, and Denver.

GRADE 10, UNIT V, LESSON 3
(Continued)

9. Ask: What is keeping the United States from developing rapid transit systems within and between cities? (Powerful automobile, oil, truck, tire, and highway lobbies keep this attractive technology from receiving wider public attention and financial support.)

Extending the lesson:

1. Find pictures of the famous cable cars of San Francisco.
2. Why are the cable cars unique? (They are designed to run on an underground cable - necessary for the steep hills.)
3. Collect pictures of high-speed trains in Japan and Europe.
4. Investigate the rail shuttle system connecting airline terminals to the central terminal at Tampa airport, Atlanta airport, Orlando airport.

Title: "Drain America First"

Concept: There are limits to supplies of fossil fuels.

Objective: To help students understand how government policies have contributed to energy shortages

Introducing the lesson:

1. S. David Freeman, Chairman of the Board of Directors for TVA, in an editorial in Energy and Education, October 1979, said: "The central issue is, will the country continue its environmentally-damaging, inflation-producing energy production policies? We have already drained America first."
2. Ask: What did Dr. Freeman mean by that?

Developing the lesson:

1. Investigate attempts by oil companies to limit or ban imports of foreign oil into this country. (Several times during the past 50 years the United States has done this by Congressional action - establishing import quotas to stimulate domestic production.)
2. Discuss the results of these governmental actions. (We pumped our own oil, when we could have been using cheap foreign oil to develop our economy.)
3. Investigate other procedures designed to "drain America first." (A process of pro-rationing - a system of state controls on production that matched well production to demand, thus making sure that there was little surplus oil on the market; this also increased demand for domestic supplies by combining scarcity with import quotas.)
4. Investigate government policies designed to increase production of domestic oil. Examples are:
 - a. A depletion allowance, intended to encourage and reward production, provided a 22 percent tax exemption because the resource was being depleted.
 - b. Royalties paid to foreign governments can be "written off" - many economists feel that these taxes should be normal expenses of doing business abroad.
5. What is the result of all these incentives to oil companies? (It makes the price of energy appear to be lower than it really is, the difference is made up by the taxpayers.)

GRADE 10, UNIT VI, LESSON 1
(Continued)

Extending the lesson:

1. Compare American and Russian policies. (Russians have continued to import oil; If the United States had done this, we would not now be so dependent on imported oil.)
2. Discuss the potential danger to the United States if its dependence on imported oil continues. (An Arab embargo could be disastrous.)
3. What are United States options in the event of a total Arab embargo? (economic collapse, military action, the end of support of Israel)
4. Investigate past policies of the electric power industry, which helped to drain America first. (Rate structures encouraged big users, promoted growth of all-electric houses and businesses. Contact the Public Service Commission and your local utility company for information concerning present changing policies.)
5. Describe your life in a "drained" America.

Title: Are We Running Out Of Energy?

Concept: There are limits to fossil fuel supplies.

Objective: To help students understand the limits of energy supplies

Introducing the lesson:

1. Ask: Are we running out of energy? (no; we are running out of fossil fuels.)
2. What is the difference? (Not much at the moment. Alternate sources of energy, such as coal and nuclear, must still be developed, and major uses of solar energy may be twenty years away.)

Developing the lesson:

1. Investigate our increasing dependence on imported oil for energy. (In 1978, the United States imported nearly one-half of the oil it used.) In 1981, oil imports totaled 41% of the oil used in the U.S.
2. Discuss the effects of this dependence on foreign supplies.
 - a. Political - susceptible to embargo or blackmail; and
 - b. Economic - severe drain on our balance of payments.
3. What are the alternatives? (increase domestic production, limit use, and use coal and uranium)
4. Can the United States increase domestic production? (Oil companies say yes - by enhanced recovery of the two-thirds of the oil resource left in wells and by increased exploration. Sceptics ask: If there is all that oil in the ground, why are we drilling in Alaska, the North Sea, and other harsh environments?)
5. Review methods and possibilities of enhanced recovery. (Tenth Grade, Unit I, Lesson 3)
6. Read and discuss the article: "The Forgotten Fundamentals of the Energy Crisis" by Dr. Albert A. Bartlett. (Available from the Office of Energy and Environmental Education, Florida Department of Education. For more information, see the October 1976 issue of The Physics Teacher.)
7. Why do Dr. Bartlett's calculations of energy supplies differ so radically from those of the media and politicians? (Dr. Bartlett's calculations are based on exponential growth as predicted; the others are based on "at present rates of use," which ignores growth.)
8. Check the validity of this statement: "Much of the energy people use is wasted."

GRADE 10, UNIT VI, LESSON 2
(Continued)

9. Suggest measures to reduce these wastes.
10. Implement those measures.

Extending the lesson:

1. Investigate other predictions of "The End of Oil Supplies" during the past 100 years.
 - a. 1891 - U.S. Geological Survey declared, "There is little or no chance of finding oil in Kansas or Texas."
 - b. 1914 - U.S. Bureau of Mines Annual Report forecast "a total future production of only 5.7 billion barrels."
 - c. 1920 - U.S. Geological Survey director predicted that the peak in domestic production had been reached.
 - d. 1939 - U.S. Department of the Interior radio broadcasts warned: "U.S. oil supply would last only 13 years."
 - e. 1949 - Secretary of the Interior stated that the end of the U.S. oil supply was almost in sight.
 - f. 1980 - same predictions, yet the American Petroleum Institute and the U.S. Geological Survey say there is considerable more oil to be found.
2. Describe your environment without oil and oil products.
3. How much new oil do we have to find? (at projected rates of use, a new "Alaska" every ten years)

Title: Florida -- The End Of The Energy Pipe

Concept: There are limits to fossil fuel supplies.

Objective: To help students understand the limits of Florida's energy supplies

Introducing the lesson:

1. It has been said that the Florida economy has been propped up by a three-legged-stool: construction, agriculture, and tourism.
2. Ask: On what are the three legs of the stool dependent? (adequate supplies of oil and gasoline at a reasonable cost)

Developing the lesson:

1. Review Tenth Grade, Unit V, Lesson 1, regarding energy use in Florida.
2. Investigate the use of energy for each of the three major industries of Florida:
 - a. transportation - over 50 percent of Florida's energy use;
 - b. construction; and
 - c. agriculture - Florida uses more energy per acre than any other state because its sandy soil needs much irrigation and fertilizer; climatic conditions also require heavy use of pesticides which require large amounts of petrochemicals.
3. What is the rate of increase in electricity use in Florida? (Almost twice the national average; energy consumption since 1960 has increased 2.7 percent compared with 1.7 percent nationwide; the average Floridian uses 40 percent more electricity than the average American.)
4. Where does most of the Florida energy go? (It goes up in smoke and pollution to keep residents and tourists on wheels and to generate electricity.)
5. Why is it said that Florida is at the end of the energy pipe? (end of the supply pipe - far from coal mines and oil refineries; and end of the priority pipe because people freezing in the North get priority over cooling in the South)
6. Discuss how Florida is similar to a developing nation in terms of energy supplies. (They both import coal and oil directly and also import energy indirectly in the form of materials, goods, and services because there is no industry; both ship out raw materials, process little, import back much, and compete with other places for the tourist dollar.)

GRADE 10, UNIT VI, LESSON 3
(Continued)

7. Where is all the needed energy going to come from?
 - a. electricity, say some; (People forget that electricity is an inefficient user of fuels - about 70 percent of the energy used in generation is lost.)
 - b. nuclear - the future is very uncertain;
 - c. solar - technology is available, but wide use is a long way off; and
 - d. a mix. (Dr. Howard Odum of the University of Florida says that the alternatives are all energy losers.)

Extending the lesson:

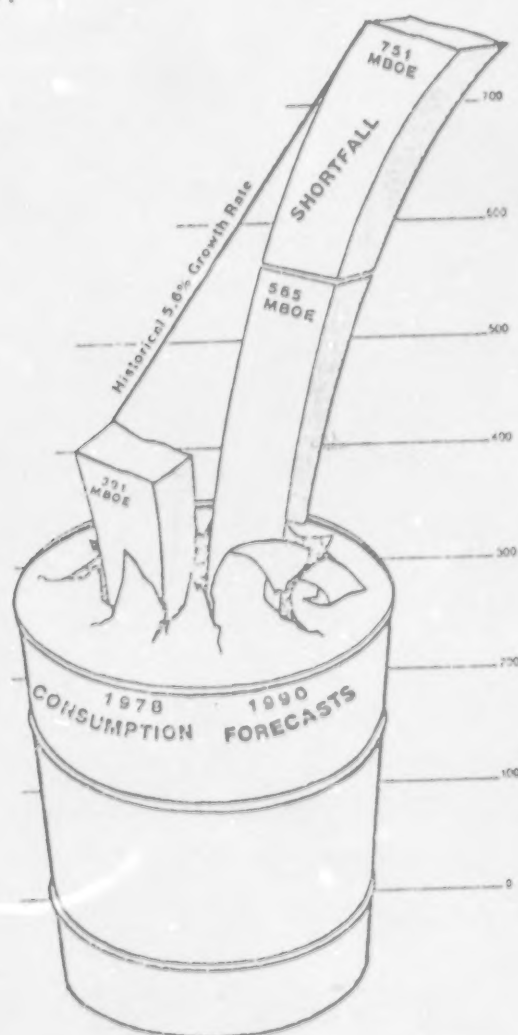
1. Why is the Florida situation unique? (Florida has no coal, little oil, no geothermal, no tides, perhaps could use the Gulf Stream.)
2. So what are the realities? (There may be oil off Florida's north-east coast - the U.S. Geological Survey estimates have been reduced from 100 billion to 6 billion barrels; there are few railroads to import coal; gas via existing pipelines may be Florida's best bet.)
3. How does fuel uncertainty affect power planning? (It is difficult to plan new power plants without fuel supply guarantees.)
4. What if the worst happens - oil declines, new supplies expensive, no capital for new power plants, returns from solar less than expected? (It means greatly altered lifestyles, abandoned cities for small towns with energy self sufficiency; people would have to live close to work; have wood stoves and natural "cracker" air conditioners for homes.)
5. How about industries for the future? (New ones will be based on recycling, renovation, and small-scale technology.)
6. Describe the "new" lifestyles. (There would be less unemployment, people labor replacing machines; government role reduced as smaller units become more self-sufficient.)
7. Plan now to make the predicted changes in lifestyle tolerable or even better.
8. Advertise your plan.

FLORIDA'S 25% ENERGY SHORTFALL
(Millions of Barrels of Crude Oil Equivalent)

This graph illustrates the potential 25 percent energy shortfall forecast for Florida in 1990, unless conservation measures are adopted. This forecast assumes that Florida's increased energy consumption through 1990 would continue at the historical rate of 5.6 percent per year. In 1978, Floridians consumed the energy equivalent of 390 million barrels of oil. Based on past consumption rates, Florida will need 751 million barrels of oil equivalent energy in 1990.

However, the U.S. Department of Energy forecasts 564 million barrels of oil equivalent energy will be available in Florida in 1990.

This means the state would be 187 million barrels short of anticipated demand, a 25 percent shortfall in available energy.



Title: Energy And Clean Air

Concept: Fossil fuel use produces wastes that pollute the air.

Objective: To understand the effects of energy use on the environment

Introducing the lesson:

1. Say: An Environmental Protection Agency chemist said: "Emissions from the burning of fossil fuels, especially high-sulphur oil and coal, combine with atmospheric water to produce sulfuric acid and nitric acid, the strongest we know of." (These fall on the earth as "acid rain.")
2. Get a copy of the Clean Air Act from your Congressman.

Developing the lesson:

1. Investigate the formation of acid rain. (Sulfur dioxide plus water forms sulfuric acid.)
2. Locate the areas of the United States where acid rain is a problem - New York, New England, Minnesota - on a map.
3. Locate the areas from which many of the sulfur dioxide pollutants originate - Ohio Valley, Ontario.
4. Discuss the effect of the westerly winds over the United States in carrying pollutants. (Effected areas are east of sources.)
5. Investigate similar problems in Scandinavia, Greece, and Italy.
6. Investigate effects of British pollution on Norwegian waters and air. (Major rivers in Norway, which once supplied salmon for world markets, are now so acid that fish will not enter them to spawn.)
7. How acid is the rain in eastern North America? (According to Dr. George Hendry of the Brookhaven Laboratory in Upton, New York, during some downpours, acidity soars to 1,000 times normal, literally comparable to having vinegar pour from the sky.)
8. Investigate damage to lakes from acid rain. (Many New York lakes are completely sterile.)
3. Investigate acid rain damage to soil. (It causes irreversible decrease in calcium - a buffer to soil acidity - by leaching; this calcium can only be replaced by geologic processes which take thousands of years.)

Extending the lesson:

1. Investigate possible effects of air pollution on human health. (Hyperacidity causes fish to assimilate mercury, posing a threat to people who eat a lot of fish; some Minnesota lakes already contain fish with unsafe mercury levels.)
2. Discuss the future air quality with vastly increased use of coal as a fuel.
3. Investigate acid damage to famous marble buildings such as the Parthenon in Athens and churches in Italy.
4. Investigate the use of "scrubbers" in industrial smokestacks to reduce air pollution from coal exhaust. (Sulphur dioxide is pumped into a large container and mixed with a slurry of lime to produce removable calcium sulfates and sulfites.)
5. Investigate the clash between the electric power industry and the Environmental Protection Agency over enforcement of Clean Air Act regulations.
6. Investigate the present enforcement policies of the EPA. Write to the EPA in Washington, D.C.
7. Investigate use of air pollution equipment on automobiles.
8. Investigate the controversy surrounding plans to build power plants near coal mines in Utah that would threaten national parks with air pollution.
9. Discuss why owners of industries locate their homes in the northwest sections of major cities. (Pollution from their plants is carried east by prevailing "westerlies." Example: New York City's Westchester, Chicago's northwest suburbs, Philadelphia Main Line. Poor people live on east side.)
10. Locate major industries in your city or community.
11. Debate the question: Pollution or power?

Title: Energy And Clean Water

Concept: Wastes from energy production and use pollute the water.

Objective: To understand how energy use effects the environment

Introducing the lesson:

1. Read the following statements concerning what might be done about oil spills and their effects on the environment, both made in January 1977.
 - a. Russell Train, Administrator, Environmental Protection Agency: "All tankers which use U.S. ports should be held to strict standards of design, construction, operation, maintenance, surveillance and boarding."
 - b. William Coleman, Secretary of Transportation: "The day of the gunboat is over. We are going to get into a heck of a lot of trouble with the rest of the world if we unilaterally impose safety regulations."

These two contradictory statements by government leaders clearly indicate the difficulties in setting standards for safe oil tanker operation.

Developing the lesson:

1. Write to your Congressman for a copy of the "Ports and Waterways Safety Act of 1972" and other information about legislation concerning oil spills, etc.
2. Investigate oil spills from tanker accidents.
3. Investigate the major spills from oil well "blowouts" off Santa Barbara, California, and the Ixtoc well off the Mexican coast which polluted Texas beaches.
4. Investigate the current administration regulations for tankers entering United States' waters. (double bottoms, segregated ballast to eliminate discharge of oil with ballast water, radar to avoid collisions, emergency steering standards)
5. Discuss whether these regulations reflect Mr. Train's or Mr. Coleman's views.
6. Investigate use of detergents and dispersant chemicals on oil spills.
7. Discuss this statement by Ira Gabrielson: "More animal life was killed by chemicals used in the Torrey Canyon accident than by the oil itself."

GRADE 10, UNIT VII, LESSON 2
(Continued)

8. Investigate oil pollution from refineries.
9. Investigate the work of Florida's pollution control agencies.

Extending the lesson:

1. Explorer Thor Heyerdahl reported "globes of oil" all across the Atlantic Ocean as he floated on his raft, Ra II. What were they? (tar, containing the most toxic parts of crude oil, resulting from spills and discharge of ballast water)
2. Investigate effects of oil spills on sea life.
3. Investigate reports of natural oil spills by early explorers.
4. Investigate attempts to cope with international oil pollution. (1954 - International Convention for Prevention of the Pollution of the Sea by Oil. The United States enacted enabling legislation in 1961, prohibiting oil waste discharges within 50 miles of any coast.)
5. Discuss why the Coast Guard feels it is impossible to enforce the Convention. (No one has ever been convicted, and if they were, the fine is only \$2,500; it would require a large fleet of ships to police.)
6. Investigate waste heat from power plants as a water polluter. (thermal pollution)
7. Contact the Department of Natural Resources in Tallahassee, Florida, for information on legislation, examples of, fines for oil spills.

Title: Oil Rigs And Marine Life

Concept: Offshore oil rigs provide homes for marine life.

Objective: To understand the environmental effects of offshore oil drilling and production

Introducing the lesson:

1. One of the big, unanswered questions relative to offshore oil exploration and production is: How does oil effect the marine environment?
2. Write to Exxon Corporation for a copy of the report on "Offshore Ecology Investigation," by the Gulf Universities Research Consortium.

Developing the lesson:

1. What was the Offshore Ecology Investigation? (It was a two-year multi-disciplinary study of the effects of oil on the marine environment of Timbalier Bay in the Gulf of Mexico.)
2. What is the Gulf Universities Research Consortium? (It is a non-profit organization with 20 university members situated along the Gulf coast from Florida to Mexico; it is headquartered in Houston, Texas.)
3. How was the study funded? (It was funded by 82 industrial sponsors who pledged \$1.5 million plus logistical support.)
4. Why was the study done? (The oil industries need to know and the question had long been a source of debate among ecologists.)
5. What effect does long-term offshore oil production and exploration have? (With a few exceptions, little adverse effect and some benefits to marine life.)
6. Why the study of Timbalier Bay? (This is a productive estuarine system with over 175 drilling platforms; if there are effects, they should be found there.)
7. How extensive was the study? (More than 1.5 million data samplings during 8 seasonal field trips and 22 others.)
8. What were the major findings regarding:
 - a. plankton - unaffected; (Dr. James Marum of Florida State University said: "The sum total of evidence indicates the zooplankton communities are similar to other Northern Gulf areas and have not changed in the last 20 years.")

GRADE 10, UNIT VII, LESSON 3
(Continued)

- b. hydrocarbons - no different than other areas;
- c. benthic marine plants - some disruption during platform construction; (Dr. Harold Humm of the University of Florida says: "The distribution of algae is apparently not affected by oil wells")
- d. oyster reefs; (Dr. Robert George, University of North Carolina, says: "Productive oyster reefs occur in the vicinity of oil platforms.")
- e. carbon - the offshore area near Grand Isle, a center of oil activity, is one of the most organically rich ecosystems of its type in the world;
- f. sediments - come from the Mississippi River, not oil wells;
- g. fish - no adverse impact on the industry; and
- h. invertebrates - sea worms typical of unpolluted water found in abundance.

Extending the lesson:

1. What were the "spinoffs" of the study? (Much information was gained about the impact of the Mississippi River and its sediments and about poisons on Gulf ecosystems.)
2. What about oil transport activities and major spills? (These are capable of major pollution.)
3. Investigate use of artificial reefs in Florida waters by the Department of Natural Resources.
4. Read about the accidents on the oil rigs in the North Sea which capsized and killed many workers.
5. Why are there no oil platforms off the Florida Gulf coast? (More than 30 wells have been drilled - all dry holes, so exploration off the Florida coast has been curtailed.)
6. How about the Atlantic coast? (The shelf is very narrow due to erosive action of the Gulf Stream.)
7. Discuss the effects on Miami Beach should oil rigs be built offshore.

ENERGY AND MY ENVIRONMENT

SUPPLEMENTAL ACTIVITIES
FOR
GRADE NINE AND GRADE TEN

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Title: A Solar Farm

Purpose: To debate whether a solar farm should be allowed in Florida and in the United States. People will be forced into making decisions that will affect their lifestyles and the environment

Procedure:

1. Tell the students that they will be forced into making decisions that will affect their lifestyles and the environment.
2. Plan a debate to address the issue of whether or not a solar farm should be allowed in Florida.
 - a. Select four students to debate for the issue.
 - b. Select four students to debate against the issue.
3. Plan a second debate to address the issue of whether or not a solar farm should be allowed in the United States.
 - a. Select four students to debate for the issue.
 - b. Select four students to debate against the issue.
4. Select students to judge the debates. (Have judges ballot secretly; have teacher hold results.)
5. Allow time for research and then have alternating team positions debated.
6. Conclude the activity by having each person write a one page paper: "After Hearing The Evidence, This Is What I Believe."
7. Compare judges' decisions with positions revealed by the students' papers.

Title: Efficiency

Activity: Compare the efficiency of automobiles and airplanes in moving people from Tampa to Atlanta

Purpose: To show that a car may be more or less efficient than a plane for moving people

Procedure:

1. Explain and give a working definition of efficiency.
2. Do the following activity as a class to compare the efficiency of automobiles and airplanes in moving 100 people from Atlanta to Tampa.
 - a. According to one of the major airlines, a Boeing 727 uses approximately 1860 gallons of fuel per hour.
 - b. It is approximately $1\frac{1}{2}$ hours flying time from Tampa to Atlanta.
 - c. The 727 would use approximately ____ gallons of fuel from Tampa to Atlanta.
 - d. If automobiles average 18 miles per gallon and the distance from Tampa to Atlanta is 540 miles, it would take ____ gallons of fuel for an automobile to go from Tampa to Atlanta.
 - e. At the average of 2 persons per automobile, at the above rate, how many gallons would it take for 100 persons in 50 cars? ____
 - f. Calculate the amount of gallons required to take 100 persons in a 727 and by automobile (varying numbers of passengers per automobile).
3. Make up your own problems and do calculations using the following data:
 - a. 4 persons per car (thus needing only 25 cars);
 - b. a DC-10, which uses 2730 gallons of fuel per hour but carries 327 passengers.
4. As more passengers were added in the automobiles, what happened to the efficiency (miles per gallon) of the cars? (Realize that mileage should drop some.)

Title: Efficiency

Purpose: To have students think about their energy use.

Procedure:

1. Have students list 12 major appliances used in their homes regularly.
2. Say: If there were a law that said you had to use less electricity, draw a pencil line through the three appliances in your list you could do without.
3. Have students circle in pencil the three that really mean the most to them and that they would hold on to until the very end.
4. Say: Now look back over your list and your decisions. Consider:
 - a. Why did you decide to do without the three items?
 - b. Why did you want to keep the other three?
5. Have students list some efficiency steps they can take to reduce the energy and money consumed by each of the three appliances they would hold on to until the very end.

Title: Efficiency

Purpose: To have students learn about their water heater and their family's hot water needs

Procedure:

1. Say: The first thing you need to learn about is your family's water heater. Some things you need to know are:
 - a. What type of water heater is it - gas, electric, or oil?
 - b. How old is it?
 - c. Is it insulated? Does it have an insulating blanket outside?
 - d. What is its capacity? (How much water can it hold?)
 - e. At what temperature is its thermostat set? What is the actual temperature of the water in the heater? (To find this out, draw water from the heater through a faucet near the bottom and check it with a thermometer.) Remember, the water, when it comes out of your kitchen faucet, etc., will not be the same temperature as it is in the heater. The further it travels through pipes, the cooler it gets.
2. Say: Too small a water heater will not give your family enough hot water; too big a water heater will be operating inefficiently by heating unused water. So the next thing you need to discover is how much hot water your family uses. To do this, find out:
 - a. How many loads of clothes are washed each week?
 - b. How many loads of dishes are washed each week?
 - c. During each week, how many showers or baths are taken and for how long?
3. Say: This information is then converted to daily hot water usage with the following factors:

<u>Task</u>	<u>Average Hot Water Consumed per Load or Bath</u>	
Clothes Washing	(Hot water wash)	24 Gallons
	(Warm water wash)	12 Gallons
Dish Washing		10 Gallons
Bathing	(Short shower or bath)	20 Gallons

4. Say: Total your family's weekly use of hot water and then divide by seven to get daily hot water use.
5. Ask: How does your family's daily hot water use compare with your water heater's capacity? Is the heater's capacity too small? Unnecessarily large?

GRADE 9, UNIT 1, LESSON 2
(Continued)

6. Put the following table on the chalkboard.

Family Size	Gallons of Hot Water Used Daily
2	23
3	32
4	40
5	48
6	57
7	65

- a. Say: This table gives the national average daily hot water requirement for different sized families.
 - b. How does your family compare? Does it use less? Does it use more? Why?
7. Ask: Why might you run out of hot water on one day during the week but not on other days?
8. Ask: What are some ways to cut down on your family's hot water use?

Title: Efficiency

Purpose: To investigate what is being done by the automobile industry to make cars more energy efficient

Materials: A copy of IMPROVING WHAT WE DRIVE (on next page) for each student

Procedure:

1. After sitting in lines in 1974 and again in 1979, paying more than ever imagined for a gallon of gasoline, Americans are concerned about the future of the automobile. We are going to look at what is being done in automobile related industries to make the mode of transportation more efficient and less dependent on foreign oil. Future fuels, improvements in auto design, and the state of research and development of alternative automobiles will be examined.
2. Give each student a copy of Improving What We Drive. Explain that currently this is one direction that the automotive industry is moving, the improvement of the automobiles as we know them.
3. Each item can be discussed, or reports on specific developments can be assigned. Each item could make an interesting group report, or an individual extra credit report. Students could be encouraged to call or write the major automobile manufacturing representative in your area or in Detroit.
4. Assign each student to design an automobile improving on one or more facets of its design. The design should be labeled as to what was improved. Individual presentations could be made and a bulletin board display arranged. If a student cannot draw, have them sketch and explain their design improvement.
5. Students may wish to build models of the cars' new designs. This could be an extra credit project. In Detroit, design ideas are often done in clay.

Improving What We Drive

In view of the current energy crunch and our growing dependence on oil, the automobile industry has specific fleet averages to attain each year. To do this, the industry must manufacture more energy efficient automobiles. From talking with industry experts, the improvements now being made have been listed.

- o Better performing engines.
- o Smaller engines that are supercharged or turbocharged to give immediate power.
- o Lighter bodies.
- o Better aerodynamic design for reduced friction.
- o Reduced drag (reducing atmospheric drag in body design, using ventilating systems, reducing contact drag by using radial instead of bias ply tires).
- o Reducing internal friction (by using high quality oils, changing oil filter, use of synthetic oils).
- o Reducing the engine load created by accessories (e.g., air conditioning); by developing lighter metals.

Based on these concepts, your assignment is to design an auto improving its efficiency in any one or more ways listed above. Label and identify all modifications made.

Title: Efficiency

Purpose: To review the history of transportation and have students design future types of transportation

Procedure:

1. Have students collect pictures and information concerning old, new, and future means of transportation that include:
 - a. cost of purchase;
 - b. cost of use;
 - c. kind of fuel used;
 - d. how fast and far they travel;
 - e. effects on the environment;
 - f. used for public or private transportation; and
 - g. used mostly in urban or rural areas or both.
2. Have students discuss the information they have found.
3. Compile this information along a dateline (beginning with mode of transportation) and make a classroom display.
4. Say: Until recently, changes in transportation were an attempt to meet people's needs and wants. Today desirable changes in transportation must also be mindful of our limited energy resources and our ecological responses. Future means of transportation will be more mindful of these concerns and limitations.
5. Have students draw a picture of a new way to travel. They should be prepared to tell how it is run, the type of fuel used, its cost and its effect on the environment. Be prepared to share these in the next lesson.
6. End this lesson by asking students if they think people will continue to travel by car as much as they do today. Discuss reasons why or why not.

Title: Efficiency

Purpose: To research by interview how things were done in "the good old days" and compare findings with present-day methods

Materials: Copies of "The Good Old Days" -- Or Were They? (on the following pages)

Procedure:

1. Give a copy of "The Good Old Days" -- Or Were They? to each student.
2. Have students discuss how they think their grandparents or great-grandparents would answer these questions.
3. Have students interview an older person (seventy-five or older) who can answer the questions.
4. After the interviews are completed, have students discuss the answers given and compare these answers with how they thought these questions would be answered.

"The Good Old Days" -- Or Were They?

Interview someone who is old enough to remember what life was like before the days of high technology, plastic, electronic games, television, and multiple gadgets. Ask this person the questions on these pages and others you may think of.

1. How did you heat your home? _____

2. What kind of fuel did you use for heating and cooking? _____

3. What did a work week consist of in days and hours? _____

4. How did you buy the necessary things: food, clothing, medicines, etc.? _____

5. How did you get to work? _____

6. How did you get to school? _____

7. Did your family own a car? _____
8. If so, what kind of car was it? _____

9. How much did it cost? _____
10. What kinds of entertainment did you enjoy? _____

11. What was clothing made of? _____
12. How was it kept clean? _____
13. What kind of a laundry machine did you have? _____

14. How did you heat the water? _____
15. What were soaps like? _____
16. How did you dry clothes? _____
17. What were the eating facilities like in your school? _____

18. What kind of bathroom did you have? _____

19. What did you have for school supplies? _____

20. Today, plastics are used so much in packaging. What did you use? _____

21. Was milk delivered? _____
22. How did you keep food from spoiling? _____
23. What was your home lighted by? _____
24. Did your family go on vacation? _____
25. If so, how did they get there? _____
26. What were roads like then? _____
27. What happened to your old schoolhouse? _____
28. How did your school change with the coming of school buses? _____

29. How do you think the car changed things in your town (or city)? _____

GRADE 9, UNIT 1, LESSON 3

Title: Sea Thermal Power

Purpose: To produce fresh water and energy from a Thermal Power Plant

Materials: cardboard box (cereal), plastic wrap, salt, water, 2 flat pans (cakepan and icecube tray), thermometer

Procedure:

1. To set up a solar water desalinator, cut a box diagonally from front bottom to top back, producing a slope-faced container.
2. Now remove the back of the box.
3. Cover this face with plastic wrap and fasten.
4. Punch a hole in the top back of the box large enough to place a thermometer.
5. Place this box over a pan containing a shallow layer of "salt water."
6. Place a tray under the front edge of the plastic-covered box to collect the fresh water.
7. Place this apparatus in the sunshine, take the temperature of the air in the box and then wait.
8. Later, check to see if any water has condensed and run down the plastic wrap and into the tray. Also, check the thermometer reading.

Conclusion should indicate that fresh water was produced and heat was collected which could be used to do work.

Title: Animal Power

Purpose: To show present dependence on machines for farming and to investigate how farm practices have changed

Procedure:

1. Have the students talk with their parents and grandparents concerning farm practices in the "good old days," when farmers did many tasks by hand or with the aid of animals.
2. Have the students review research information about countries that today still use a lot of animal power in their farming procedures.
3. Have students research present methods of farming in the U.S. and machines used.
4. Have the students write or discuss how machines have helped in food production and how they have created new problems (such as inefficiency in harvesting, compacting the soil, increased used of fuel, etc.).

GRADE 9, UNIT 11, LESSON 2

Title: Offshore Oil

Activity: Marine life on man-made artificial reefs

Purpose: To study how plants and animals can flourish with man's assistance or be destroyed by his carelessness

Procedure:

1. Have the students research barriers created in the gulf or ocean by dumping automobile tires, cement and rock, or by breakwaters.
2. Discuss how plants and animals have adapted to these barriers and are flourishing.
3. Compare these barriers with a drilling rig. (the legs, cables, etc.)
4. Then have the students express concerns as to the oil drilling process and its potential threat to plant and animals of the sea.
5. Finally, debate the possible benefits (oil, gas and animal/plant) vs. the possible disadvantages (oil, chemical spills).

GRADE 9, UNIT 1, LESSON 3

Title: Oil From Rocks

Activity: Changing tar into a liquid

Purpose: To show that petroleum products exist in all three states: gas, liquid, solid

Materials: Bunsen burner, ring stand, an old metal container (tin can), a lump of roofing tar, and a splint

Procedure:

1. Design and set up apparatus
2. Heat a piece of hard roofing tar in an open can over the bunsen burner.
3. Show that petroleum can exist in different states by first displaying the solid. (hard roofing tar)
4. Then the solid can be liquified by heating.
5. Show that the vapors coming off are gas by placing a burning splint in the vapors being produced.

Title: Refining Oil

Activity: Determining the many uses of crude oil

Purpose: To show our dependence upon fossil fuels in their final commercial form

Materials: Copies of WORD STUDY LIST and ENGINE PUZZLE (on following pages)

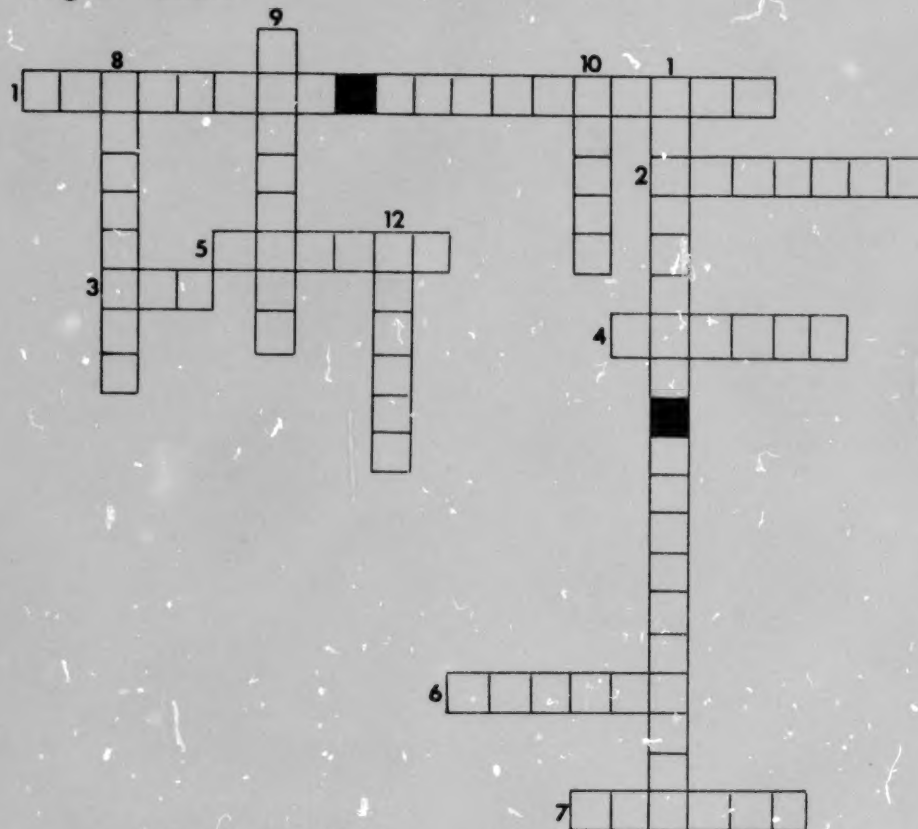
Procedure:

1. Divide the class into teams assigned to research:
 - a. the use of fossil fuels in the production of medicine;
 - b. the use of fossil fuels in the production of foods;
 - c. the use of fossil fuels in the production of clothing;
 - d. the use of fossil fuels in the production of an automobile; and
 - e. the use of fossil fuels in transportation.
2. Have each team debate why fossil fuels must be saved and why fuels must be available for their topic of research.
3. Establish a class list of priorities for the use of fossil fuels.
4. Use the word list and puzzle on the following pages to review the types of engines available for getting work from fossil fuels.

Word Study List

1. Steam engine - reciprocating external combustion engine.
2. Steam turbine - non-reciprocating external combustion engine.
3. Gasoline engine - a four-cycle internal combustion engine requiring spark plugs.
4. Ramjet - a jet with no moving parts.
5. Turbojet - an engine with a turbine-driven air compressor used in most high-speed aircraft.
6. Fanjet - a jet engine in which some air by-passes the combustion chamber.
7. Rocket engine - only engine that will operate in the vacuum of space.
8. Diesel engine - internal combustion engine which requires no spark plugs.
9. Turbine - an engine turned by the force of a gas or liquid acting against its vanes or blades.
10. Jet engine - engine that gets thrust from high speed exhaust gases.
11. Engine - a machine that changes another form of energy into mechanical energy.
12. Reciprocating engine - engine which converts heat energy to mechanical energy by the back and forth motion of a piston in a cylinder.
13. Wankel rotary engine - a small gasoline engine that does not use pistons.
14. External combustion engine - the kind of engine in which the fuel is burned outside the engine.
15. Internal combustion engine - the kind of engine in which the fuel is burned inside the engine.

Engine Puzzle



Across

1. The kind of engine in which fuel is burned outside the engine.
2. This engine is turned by the force of a gas or liquid acting against its vanes (blades).
3. The engine that gets thrust from high speed exhaust gases.
4. A jet in which some air by-passes the combustion chamber.
5. An internal combustion engine which requires no spark plug.
6. The only engine that will operate in a vacuum.
7. A small gasoline engine that does not use pistons.

Down

8. An engine with an air compressor used in most high-speed aircraft.
9. A four-cycle internal combustion engine requiring spark plugs.
10. Non-reciprocating external combustion engine.
11. The kind of machine in which fuel is burned inside the engine.
12. A machine that changes another form of energy into mechanical energy.

Title: Appropriate Technology

Activity: Determine if your community has sufficient winds to operate wind-mills.

Purpose: To check the feasibility of wind power as an energy source.

Materials: Anometer

Procedure:

1. Research the amount of winds (the speed) needed to produce electrical power (or water). Set up an anometer and record readings at least 4 times daily over several weeks. By using the observations and the information from research, have the students write a statement as to the appropriateness of windpower.

or

2. Have the students research the amount of winds needed to produce sufficient amounts of electricity, and then have them check with various weather stations throughout the state as to their daily and monthly winds and their patterns. The students then will justify placing a windmill at the "best" place.

Title: Garbage Power

Activity: Build a methane generator

Purpose: To change energy from a non-usable to a usable form

Caution: This experiment can be dangerous.

Procedure:

1. Place a mixture of water, animal manure and grasses (enough water to make a slurry; start with a 2-3 mixture) in a sealed container having an outlet.
2. Hook the outlet to an inflatable device such as a balloon (inner tube if you plan a large production) so that varying air pressures will not explode the container.
3. A water bath that will surround the container and can be heated (fish tank heater works fine) to 80-90 degrees F will speed up the reaction.
4. Initially, vent the gas as it is being produced. This will prevent the explosive mixture of gas and air being present.
5. Collect a balloon full of gas. Vent it through a hose and glass tube (such as an eye-dropper) and subject the gas to a flame.
6. Discuss uses of methane as a fuel for various activities.
7. Research the production of methane from cattle manure by Kaplan Industries in Bartow, Florida.

Title: Light

Activity: What is the color we see?

Purpose: To show, using white light, why an object has a "color"

Materials: White light source, white, green, red, blue paper, and a prism

Procedure:

1. Place the prism between the white light source and the white paper.
2. Focus the spectrum onto the white paper and record the order of the colors.
3. Place different colored sheets of paper in place of the white sheet and record the order of the colors.

CONCLUSIONS:

Students should note their observations and any inconsistencies. From this information, they then should conclude the color of light that is seen is that part of the spectrum which reflected from a surface.

Title: The Tides

Activity: Investigate the possibilities of tidal power to produce electricity

Purpose: To research energy potential created by tides as a visible energy source

Materials: Research documents/source materials

Procedure:

1. Research how tidal power is being used in France at the LaRance estuary. (A film is available through your local electric utility.)
2. Research tidal patterns in Florida.
3. Research criteria necessary for production of energy from tidal power.
4. Review potential problem of tidal power, e.g., damage to marine life, dredging, access to rivers and keys, etc.
5. Write a summary of findings and report to the class a recommendation.

Title: Solar Electricity

Activity: Demonstrate models using solar cells

Purpose: To show that with current technology solar energy can be changed into electrical, but is not yet economically feasible

Materials: Several solar cells, a solar array, several small electrical motors, and model (toy) cars, boats, fans, lights, etc.

Procedure:

1. Research and discuss the process of how a solar cell produces electricity.
2. Set up models involving light bulbs, fans, a car driven with a solar cell, etc.
3. Discuss advantages of the solar cell use in remote areas: (no moving parts, etc.)
4. Contact the Florida Solar Energy Center in Cape Canaveral for information.
5. Discuss the "state of the art" in solar cell production. Research present cost of solar cells.
6. Have the students write a report on the feasibility of a solar powered car. (cloudy day, batteries, etc.)

Title: Solar Electricity

Purpose: To determine the energy generated by a solar cell

Materials: voltmeter, an ammeter, a solar cell

Procedure:

1. Say: Presently, most of our energy requirements are met through using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.
2. On a board, connect the solar cell to the voltmeter and ammeter. Then have students take this instrument outside to experiment. Ask the students to determine the best angle of the solar cell to get maximum volt and ampere readings. Record this data.
3. Back in the classroom, have students determine the wattage by multiplying volts by amps. From this data, convert wattage to number of kilowatts.
4. Ask:
 - a. How does the wattage produced by the solar cell compare with the wattage required by some household appliances?
 - b. How does the number of kilowatts produced compare with a typical family's monthly consumption?
 - c. Could solar cells be used to power a city?
 - d. A home?
 - e. How much surface area of solar cells would be required to produce the power needed for a home?
 - f. What factors affect the efficiency of a solar cell?

Title: Changing Life Patterns

Purpose: To emphasize how lifestyles are determined by energy availability

Materials: Copies of a survey drawn up by the class, participants for the survey

Procedure:

Have students go out and survey their neighborhood asking questions such as:

1. Have you bought a new car in the past ten years?

If yes, what did you consider when buying that car (fuel-economy versus gas guzzler)?

2. Have you made any improvements on your house in the past ten years or had a house built?

If yes, were these energy-related improvements? Was the new house designed to conserve energy?

3. What sort of recreation does your family participate in? Has that recreation changed over the past ten years? Why?

4. Does your family have a small garden in the backyard? Why or why not?

5. What is your occupation?

It is best for the students to draw up their own questionnaire as a class, thus the topics would be of more interest to them. After the survey is completed, it would be a good idea to take some class time and evaluate the results according to occupations of the participants discussing the results.

Title: Changing Life Patterns

Objective: To determine whether wise food choices can save energy

Materials: Copies of WORKSHEET and ENERGY PRICES (on the following pages)

Procedure:

1. Review the items offered in the menu and select your "first choices" based on your likes and dislikes. Place checks beside those items in Column 1.
2. Make selections from the menu on the basis of least energy use. Make your decisions with the following in mind: The energy cost of a food includes things like fertilizers, insecticides, equipment, feeds, transportation, processing, packaging, advertising, and preparation. Place a check by each low energy item in Column 2.
3. Now refer to the Energy Price List for each item's energy cost. Show the "price" of each item you chose and determine your total bill.

*Note: Prices might have changed, but will continue to be proportional.

4. Discover how much energy you could have saved by finding the difference between the individual items in the two columns and enter those figures in Column 3. Add the total "pluses and minuses" in this column to find total energy savings.
5. If you were to select items for Column 1 (choices) again, would your choices be any different?

WORKSHEET

APPETIZERS (Choose one juice,
one cracker & butter or margarine)

Fresh Orange Juice	_____	_____	_____
Frozen Orange Juice	_____	_____	_____
Cracker A	_____	_____	_____
Cracker B - wrapped individually	_____	_____	_____
Butter	_____	_____	_____
Margarine	_____	_____	_____

MAIN DISH (Please make a First &
Second choice as we do not always
carry each entree)

Luncheon Meat	_____	_____	_____
Chicken	_____	_____	_____
Turkey	_____	_____	_____
Rice with Vegetables	_____	_____	_____
Beef (grass-fed)	_____	_____	_____
Beef (grain-fed)	_____	_____	_____

VEGETABLE (Sorry, today we
have only carrots, but you may
choose your preferred type.)

Fresh Carrots	_____	_____	_____
Dehydrated Carrots	_____	_____	_____
Frozen Carrots	_____	_____	_____
Canned Carrots	_____	_____	_____

DRINKS (Please choose a First &
Second Choice as we sometimes run
short of one kind of drink at lunch)

Soft Drink (in aluminum can)	_____	_____	_____
Soft Drink (in returnable glass bottle)	_____	_____	_____
Milk	_____	_____	_____
Beer (in aluminum can)	_____	_____	_____
Beer (in returnable glass bottle)	_____	_____	_____

DESSERT (Choose One)

Apples (Homegrown in our cafeteria's own garden)	_____	_____	_____
Apples (store-bought)	_____	_____	_____
Walnuts (shelled)	_____	_____	_____
Walnuts (unshelled)	_____	_____	_____
Ice Cream	_____	_____	_____

TOTAL BILL

ENERGY PRICES

(Prices are proportional to actual energy expenditure)

APPETIZERS

Cents

Fresh Orange Juice	.12
Frozen Orange Juice	.46
(Freezing and processing use a great deal of energy, both initially and for storage.)	
Cracker A	.10
Cracker B (individually wrapped)	.15
(Food excessively packaged or only available in small packages is more energy-intensive than wrapped foods of foods available in bulk.)	
Butter	.15
Margarine	.05

MAIN DISH

Luncheon Meat	\$1.60
Chicken	.96
Turkey	1.06
Rice with Vegetables	.45
Beef (grass-fed)	1.48
Beef (grain-fed)	2.08
(Animals are inefficient convertors of protein. A pound of meat requires about four times the energy to produce and market as a pound of vegetable protein. Some animals are more efficient converters of protein than others.)	

VEGETABLE

Fresh Carrots	.12
Dehydrated Carrots	.92
Frozen Carrots	.31
Canned Carrots	.23
(Processed vegetables require more energy than fresh vegetables; freezing and dehydration especially require large amounts of energy.)	

DRINKS

Soft Drink (aluminum can)	.45
Soft Drink (returnable bottle)	.31
Milk	.34
Beer (aluminum can)	.50
Beer (returnable bottle)	.25

DESSERT

Homegrown apple	.03
Store-bought apple	.19
(Homegrown apple by commercial methods saves commerce and transport; organic methods would save more.)	
Walnuts (shelled)	\$1.04
Walnuts (unshelled)	.39
Ice Cream	.60
(Large quantities of milk used; freezing is necessary.)	

Title: My Energy Use

Purpose: To explore ways to conserve energy and cut down on energy waste

Materials: (Optional) Pamphlet: Tips for Energy Savers

Procedure:

Conduct a class discussion on the best ways to conserve energy in and around the home, on the road, and in the marketplace. Here are a few important topics you might discuss:

1. Proper insulation can increase temperature-control efficiency by as much as 20 to 30 percent. Ways to protect against heat and cold: caulk and weatherstrip doors and windows, install storm windows and doors, and insulate the attic and the walls. Spring, summer, and fall are the best times to insulate.
2. Try to use energy-related appliances in the early morning or late evening hours - not during peak load hours.
3. Concentrate light in reading and working areas and replace other bulbs with the next lower wattage.
4. Turn off all lights when not needed.
5. Use fluorescent lights in suitable areas. A 40-watt fluorescent lamp gives off about 80 lumens per watt; a 60-watt incandescent gives off only 14.7 lumens per watt. The lower-watt fluorescent would save about 140 watts of electricity over a period of 7 hours.
6. Keep lamps and lighting fixtures clean. Dirt absorbs light.
7. Use outdoor lights only when essential.
8. Dimmer switches allow more efficient use of light.
9. Set air conditioning thermostats no lower than 78 degrees.
10. Lower thermostats to 68 degrees during the day and 60 degrees at night for heating.
11. Close off unoccupied rooms and turn off the heat or air conditioning.
12. Clean or replace filters at least once a month.
13. Dress appropriately for the temperature.
14. Join a carpool.

15. Drive at moderate speeds.
16. Keep your car tuned up and choose accessories wisely.
17. Vacation closer to home and try to use public transportation as much as possible.
18. Purchase equipment such as automobiles, appliances, pumps, fans, compressors, and boilers, on the basis of initial cost and operating costs rather than on basis of purchase price alone.

A good pamphlet to use: Tips For Energy Savers, by Energy Conservation Now. Furnished by Governor's Energy Office
The Capitol
Tallahassee, Florida 32301

Vocabulary: dimmer switches, efficiency, fluorescent lights, incandescent lights, initial cost, operating cost, peak load hours, and purchase price.

Title: My Energy Use

Purpose: To survey the extent to which the community is conserving energy

Concept: Energy, its production, use, and conservation, is essential in the maintenance of our society as we know it.

Procedure:

1. Review with the class the concern and pleadings from President Carter and other high government officials that the country curtail energy usage during the Carter Administration.
2. What is the attitude of the present administration?
3. Develop with the class a list of places in the community that use substantial amounts of electricity. The list would probably include homes, supermarkets, schools, service stations, public buildings, restaurants, motels, hotels, department stores, churches, and manufacturing companies.
4. Ask students to work in groups of two or three to observe their homes and one of the other places carefully to see if efforts are being made to save energy. If possible, interview the manager or some other responsible person in the place they are studying to ascertain what is being done to save energy that might not be obvious to an observer.
5. Ask each team to give a short oral report to the class on their findings. Does it appear that most homemakers and establishments are cooperating with the request to conserve energy? If the answer is no, what ideas does the team propose that might get better co-operation?

Title: My Energy Use

Purpose: To survey community attitudes regarding energy shortages

Concept: Energy, its production, use, and conservation, is essential in the maintenance of our society as we know it.

Procedure:

1. Select from the class two or three students who will, with the use of a cassette tape recorder, interview people in the community to ascertain their reactions to the energy situation.
2. Involve the class in developing questions to be used by the students in the interviews and in deciding on the population to be interviewed.

Questions might include the following:

- a. In your judgment, is there really an energy problem?
- b. If there is a problem, whose fault is it?
- c. If there is a problem, what can you do about it?
- d. What, if anything, are you doing about it?

The sample of persons to be interviewed should represent a range of ages and occupations such as homemaker, student, store owner, service station operator, trucker, salesman, custodian, and so forth.

Urge the students who are doing the interviews to speak clearly and to urge those being interviewed to do the same since the recording is to be played to the entire class for their study-reaction.

3. As the recording is played to the class, ask students to determine how perceptions of the energy problem differ. Do these perceptions vary according to income level, age, or other criteria? Are there any agreements as to what could/should be done?
4. The activity might be concluded by asking each student to write a few paragraphs on what he has learned about community attitudes toward the energy problem.

Title: Developing Nations Want More

Purpose: To probe issues of higher standard of living and increased energy consumption

Materials: Copies of ENERGY, WHO USES IT? (next page)

Procedure:

1. Distribute ENERGY, WHO USES IT? and have the students complete the chart.
2. Discuss the answers to the questions.
3. Try to answer: Why do some nations use more energy than others and is this necessary?
4. Read to the class the article ENERGY USE IN SWEDEN AND IN THE UNITED STATES following ENERGY, WHO USES IT? before discussing question #3.

Vocabulary: GNP and per capita income

ENERGY: WHO USES IT?

Look carefully at the chart on this page. Separate the nations according to their per capita GNP -- high, medium, or low. Write the letters H, M, or L in the appropriate column. (Medium means the dollar amounts come between the low and high.)

Do the same in the Annual Energy Units Column. Then answer the questions.

ENERGY CONSUMPTION PER UNIT OF GNP

Country	H,M,L	1974 Per Capita GNP*		Annual Energy Units Per Capita**
		(in U.S. Dollars)		
Afghanistan		81.		23.
Argentina		1246.		1490.
Brazil		750.		435.
Canada		5372.		7870.
Egypt		259.		241.
Ethiopia		83.		34.
France		4851.		3314.
Haiti		143.		24.
India		117.		157.
Iran		762.		865.
Japan		3813.		2755.
Laos		100.		71.
Mali		73.		21.
Pakistan		126.		68.
Saudi Arabia		1299.		813.
Sweden		6155.		5140.
Switzerland		6346.		3015.
United States		6155.		9500.
USSR		Not		3825.
		Available		

* The total value of the goods and services produced in a country divided by the total population.

** Units refer to energy consumption in barrels of crude oil equivalent per person.

1. Are high GNP nations also high energy users? Why or why not?
2. How is the presence of industry related to high GNP?
3. The United States, Sweden and Switzerland have similar GNP per capita but different energy use per capita. What factors might explain these differences?
4. How can a nation with a growing population maintain or increase the per capita GNP?
5. What two factors account for the size of the per capita GNP?

ENERGY USE IN SWEDEN AND THE UNITED STATES

Sweden and the United States both have high standards of living. The average person in both countries has a good, balanced diet, although the United States citizen eats more protein, mostly from meat. There are more doctors, hospitals, and teachers per person in Sweden, while there are more appliances such as television sets, refrigerators, and automobiles per person in the United States.

Swedish citizens are much more efficient in their use of energy for transportation than Americans. Cars in Sweden weigh less than American cars and rarely come equipped with such energy-using extras as air conditioning and automatic transmission. As a result, Swedish cars get much better mileage. Moreover, Swedes leave their cars home a lot more than Americans. In fact, over seventy percent of the commuters in Sweden get to work by mass transit, bicycle or by walking.

There are several reasons why Swedes use more mass transit and drive small cars. Mass transportation systems are cheap and efficient. Because of taxes, gasoline costs much more in Sweden than in the United States. In addition, the Swedish government places a high tax on large, heavy cars. Sweden is a much smaller country than the United States. Therefore, the distances covered by both passenger and freight travel are smaller.

Despite the fact that the average temperature in Sweden is much lower than in the United States, Sweden uses less energy per person to heat homes. Swedish homes are smaller and better insulated than American homes and many more Swedes live in apartments, which can be heated more efficiently. The heat for Swedish homes is usually generated from a central heating plant that is quite energy efficient. Finally, the interior temperature in Swedish homes is kept lower, on the average, than the temperature in most U.S. homes.

Industries in Sweden also use less energy than comparable industries in the United States. Again, this is largely the result of better insulation, higher energy-efficient construction standards and lower lighting levels.

Much of the electricity in Sweden is produced from hydropower, which is somewhat energy efficient. In addition, the Swedes use some of the heat that is a by-product of the electrical generation to heat homes and apartments.

Adapted from Lee Schipper and Allan Lichtenberg, "Efficient Energy Use and Well Being: The Swedish Example," Science, December 3, 1976, volume 194, p. 1001-1013.

Title: Developing Nations Want More

Purpose: To realize that energy problems are world-wide and that decisions concerning energy have a ripple effect

Procedure:

1. Read to the students:

Sophisticated communication and transportation systems have put people in close and frequent contact with each other. Importing and exporting practices have made countries interdependent. Decisions made in one country will have a ripple effect on many other people.

People are finding the need to get together and solve problems on an international level. Can the world's people solve the energy problem?

In this activity you will review attitudes of several citizens from a variety of countries about the use of solar energy. You also will practice using a logic framework to solve a problem.

At the completion of this activity, you should be able to:

- realize that different nations have different viewpoints depending on history, geography and economy;
- realize that the energy crunch is a world-wide problem affecting our transportation, food supply and almost every aspect of our lives;
- use a logical method to solve a problem; and
- realize that solar energy has been used significantly in the past and will be utilized again in the future as an energy resource.

2. Say: The following simulation presents viewpoints of citizens of five countries. Some countries are already developed, some just developing and one is underdeveloped.

ACTIVITY 1

SITUATION: In this simulation, a committee of the United Nations met to determine a U.N. policy and a working plan for the use of solar energy as a power source.

On one day, the committee asked representatives from five countries to speak. Each speaker related: (1) his country, (2) his present occupation, (3) what many of his people did as an occupation in the past, and (4) what he thinks the future for solar energy is in his country.

In writing a report of the meeting, the secretary dropped the notes. The secretary had the following notes - but all mixed up. The representatives were from the following countries: United States, New Guinea, Saudi Arabia, Japan and Sweden. The speaker's occupations were: farmer, industrialist, builder, merchant and ruler. Historically, their people had been: pioneers, hunters, fishermen, sailors and nomads. Their outlooks on the use of solar varied widely. They were: conservative, worried, unknown, mixed and optimistic.

GRADE 9, UNIT V, LESSON 3
(Continued)

Can you figure out: (1) the order of the speakers, (2) the speaker's country, (3) speaker's occupation, (4) his family's background, (5) his outlook on solar for his country in the future.

THE UNITED NATIONS COMMITTEE ON SOLAR ENERGY: PROGRAM			
Speaker's Country	Speaker's Occupation	Family's Historical Background	Solar Energy Outlook
1.			
2.			
3.			
4.			
5.			

CLUES FROM THE SECRETARY'S NOTES:

1. The Japanese citizen did not speak fourth, nor is he from the sailors.
2. The citizen whose family had been fishermen spoke second; the farmer spoke third; the builder spoke first.
3. The Swedish citizen spoke earlier than the industrialist, who spoke immediately before the turn of the pioneering citizen.
4. The following citizens spoke in this order, third speaker - the person giving the mixed outlook, the ruler next, then the person from New Guinea.
5. The Arabian isn't the builder, nor is he the industrialist.
6. The U.S. citizen spoke immediately before the nomadic family, while the citizen who spoke on an unknown future spoke later than the one whose family had been nomads.
7. The merchant's family used to be hunters.
8. The builder did not give the "unknown" outlook, nor is he optimistic about the future of solar energy.
9. The citizen giving the "worried" outlook is from Japan.
10. Neither the citizen from the hunting people nor the nomadic people gave the worried outlook.
11. The optimistic person was not from the sailing people, nor the hunting.

ACTIVITY 2

Read the notes made by the Secretary on each speaker's presentation. Use the information obtained in Activity 1 to determine the country each speaker is from. Fill in the blanks to indicate where each speaker is from. (If you have not completed the program in Activity 1, use the clues in these paragraphs to fill in the empty blanks in Activity 1.) The following are not in order as presented on the program.

- SPEAKER___: A pioneering spirit helped make his country great, so this farmer discussed the technological advances that help keep his people better fed than most of the other people of the world. Country___ But the advances made depended on huge supplies of fossil fuel. Fossil fuel will not last forever. "Maybe technological advances will provide a way so solar energy can supply the demands of my fuel-hungry nation - maybe not. Perhaps we could help our own economic situation and the situation in some undeveloped countries by trading solar technology for raw materials."
- SPEAKER___: Introduced as a merchant, this vender who sells from an open boat rose to discuss the changes in his country. His own father, he said, supplied his family food by hunting in the near-by jungle. Fossil fuel was not a part of their life. Solar energy was critical - plants grew, water flowed, people ate because the sun produced energy. His people would like to have the riches of other nations, but they see no way. "We depend on solar energy now, but what happens if all our people move to cities and leave the old ways? We do not know."
- SPEAKER___: The discovery of large deposits of oil drastically changed the lives of the desert nomads of his country. This citizen is now a proud well-educated member of the ruling class. His people do not now have to depend on a harsh landscape or the blazing sun for power - they sell oil. The oil will not last forever, so his people are using oil-money to build vast solar installations. "Solar power will continue to make my nation strong."
- SPEAKER___: Living on a small island has forced his people to look to the sea for food now as well as in times past. They forged a great industrial nation built on imported oil and the determination of the country's people. The people depend on solar energy to grow the rice, recycle water and provide the cooling wind. "But my people are worried. Solar energy cannot provide the power for a highly industrialized nation. Maybe nuclear is the best answer for us, unless"
- SPEAKER___: One of the speakers discussed the careful designs of homes to conserve energy. Since the country he comes from is very cold, conservation of heat energy is very critical. His people, bold seafarers from times past, will seek bold solutions to problems now. "We will continue to be conservationists and we will take advantage of the sun our northern land can capture."

QUESTIONS:

1. Which country uses solar energy most effectively now? Explain your answer.
 2. Do you think other countries could use solar energy in the same way?
 3. How have countries used solar energy in the past? Will they use solar energy the same way in the future?
 4. What difference would it make to the other countries if the United States cut its oil imports in half and used solar to a much greater extent?
 5. What other problems can be solved using a "matrix."
-

LOOKING BACK:

Write a report that the committee might have written after listening to the citizens of the five countries discussed in Activity 1 and 2. What do you feel is the outlook for the increased use of solar energy? How will an increased use of solar energy benefit each of the countries?

OR

Draw five pictures - one for each country showing a bit of the past history of each as it relates to how they used solar energy directly or indirectly.

GOING FURTHER:

Each country has a different view of the energy crisis. Pick a country and make your own presentation to the "U.N. committee" based on how you feel a citizen from that country would feel.

OR

Project to the year 2010 and picture each country discussed in Activity 1 and 2 as it might be in that year.

Title: Limits To Growth

Purpose: To develop an understanding of exponential growth and its effects

Materials: Five key statements

Procedure: Reflection on five key statements (as of 1980).

1. We live in a world that is doubling its human population every 37 years. Within the next 37 years, by 2017, we will add as many people to this earth as have been added in the entire history of mankind. Are we ready?
2. We live in a world that is doubling the size of its industrial complex every 10 years. By 1990, we will add as much industry as has been developed throughout earth's history. Are we ready?
3. We live in a nation that is doubling its consumption of oil every ten years. We will increase our use and dependence on oil between now and 1990 as much as we did from the beginning of the history of man until today. Are we ready?
4. We live in a nation whose national objective is to double our use of coal every 14 years. We will increase our use of coal between 1980 and 1994 by as much as we have increased it in the history of man. Are we ready?
5. We live in a state which is doubling its consumption of electricity every 8 years. Floridians will increase their consumption of electricity between 1980 and 1988 by as much as we have increased it since its discovery. Are we ready?

What can be done? Conservation through societal changes offers the most hope. It is cheaper, cleaner, and safer to save energy than to produce more of it. Conservation-related investments tend to be less capital demanding and provide more jobs than investments in new sources of energy. Conservation is more people-oriented in the sense that all of us can do it.

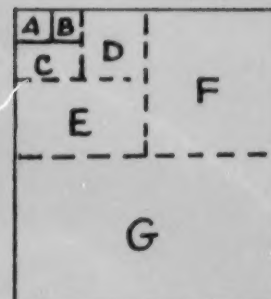
Extending the lesson:

Have students work through the following activity "Burning Bridges," by Carol Houck, Broward County Schools, Florida.

BURNING BRIDGES

BRIDGES

Our energy demands are growing "exponentially." To find out what that means take a full size sheet of paper. Fold it in half - fold in half again and three more times. Unfold your paper. Divide the top left hand box into half with a pencil line. That little area will represent man's energy consumption FROM THE BEGINNING OF TIME TO 1950! The other half of the box - the same size as the first box - represents the energy use from 1950 - 1960, only ten years! We are DOUBLING our demand for energy about every ten years.



We're running out of oil to supply that demand and we aren't ready to substitute an energy resource that doesn't run out - such as solar - on a large scale. What is going to bridge the gap between oil and some future source?

What happens if we use coal to fill that gap and burn the coal too fast? That's like burning our bridges behind us before we reach the other end.

On the paper you unfolded, mark Box A, 0-1950; Box B, 1950-1960; Box C, 1960-1970; Box D, 1970-1980; Box E, 1980-1990; Box F, 1990-2000; Box G, 2000-2010. Draw ten barrels of oil in Box A, double that number for Box B, double that number for Box C, double that number for Box D. If we double the amount of oil we use every ten years, how many barrels will we be using by the year 2010?????

BRAKES

We can "put on the brakes." Cutting our demand for coal, oil and electricity can be done many ways.

Look around the room right now. Name one way this room or building could be more energy efficient. Name one way you could use less energy in your life. Put both answers in Box E.

BALANCED BUDGETS

Energy is a flow. We cannot recycle coal or oil or electricity. Once it is used, it is gone. On the other hand, more solar power is available each day. Using more solar power, more muscle power and conserving what we have can save our fossil fuel resources and save us money - money sent to other countries to pay for oil. Name three ways you use solar power right now. Put your answers in Box F.

BOOMERANGS

We can continue to demand more energy and have the whole thing "boomerang." We can spend continually greater sums to get continually less. We can obtain increasing amounts of electricity and get increasing amounts of smog and radioactive wastes. OR we can learn the joys of doing with less so we can enjoy more. In Box G, name three activities you enjoy that require solar energy and little fossil fuel. (Hint: Eating an apple from your yard is one.)

Title: Limits To Growth

Objectives: Students should be able to:

1. Tell what basic needs of living things are.
2. Identify several problems facing people today in the energy crisis.

Materials: Copies of THOSE BILLIONS ARE INDIVIDUALS (on next page)

Procedure:

1. Explore with students the effects of vast amounts of fossil fuels used by modern technologies to produce the things people need and want. Begin by reviewing the difference between needs and wants. Point out that the differences between the two become muddled at times. For instance, is a car a necessity to a suburbanite or is it a luxury, something everyone wants? Review the words luxuries and necessities.
2. Then ask students to follow the instructions on the sheet: Those Billions are Individuals. The completion of the list should enable students to discuss the proposition that, on the whole, America has benefitted from the use of large supplies of nonrenewable fossil fuels. During the discussion, you may want to raise the question of whether the benefits will be as apparent in the future. Ask students whether society needs all the things they think they need, and, if so, whether these needs will continue to grow.

THOSE BILLIONS ARE INDIVIDUALS

1. Draw a line lengthwise down a sheet of paper.
2. On the left side, list the basic needs of every human being; water, food, clothing, shelter, etc.
3. On the right, list the things you need or want for your own life-style: color-TV, stereo, car, hot water, _____'s hamburgers, etc. Next to each item, name some of the resources or products needed to support these things: oil, electricity, iron, pesticides, grain, water.
4. Cross off 3 of the items on the right side so that people who lack the basic necessities on the left side can have them.
5. Cross off 3 more, since continued population growth and development will mean giving up such levels of consumption.
6. How many more items, if any, are you willing to cross off your list to sustain population growth as well as raising consumption in the U.S. and the rest of the world?
7. What values, if any, are in conflict?

<u>Basic Necessities</u>	<u>My Needs or Wants</u>
food	Stereo (wood, oil, electricity)
water	T.V. (metal, oil, electricity, glass)
clothing	_____ 's hamburger (grain, pesticide, fertilizer, oil, wood)
shelter	Hot water (water, oil, or gas, copper, lead, iron)
...	Baggies (water, oil, wood)
...	

GRADE 9, UNIT VI, LESSON 2

Title: Peak Power

Purpose: To learn about the water heater and how to cut down on its usage

Materials: Information collected by students about their own family's water heater

Procedure:

1. Have each student collect this information about his/her family's water heater:

- a. What type of water heater is it - gas, electric, or oil?
- b. How old is it?
- c. Is it insulated?
- d. How much water can it hold?
- e. At what temperature is its thermostat set?

*Too small a water heater will not give your family enough water; too big a water heater will be operating inefficiently by heating unused water.

2. Have students answer these questions:

- a. How many loads of clothes are washed each week? At what time of day or evening do you operate the washer and dryer?
- b. How many loads of dishes are washed each week? At what time of day or evening do you operate the dishwasher?
- c. During each week, how many showers or baths are taken and for how long? At what time of day or evening do members of your family bathe?

3. Using the information collected and the chart below, have each student convert his/her daily hot water usage to gallons.

<u>Gallons Used Per Load or Bath</u>		
Clothes Washing	(Hot water wash)	24 Gallons
	(Warm water wash)	12 Gallons
Dishwashing		10 Gallons
Bathing	(Short shower or bath)	20 Gallons

4. Have students total their family's hot water use for the week and divide by seven to find the daily hot water use.

GRADE 9, UNIT VI, LESSON 2
(Continued)

5. Ask each student if their hot water heater is too small or too large for their family.
6. The table below gives the national average daily hot water requirement.
 - a. How does each student's family compare?
 - b. What are some ways to cut down on a family's hot water use?

Family Size	Gallons Used Daily
2	23
3	32
4	40
5	48
6	57
7	65

7. Say: Since electricity must be generated to fill the demand of consumers, peak demands occur at varying times of the day and evening. To reduce the demand on your electric utility company, and to keep your electric rates lower, there are times of the day when it is best to keep electrical use at a minimum.
8. Call your local electric utility company and request information about peak load times. You might wish to have a representative come to the class and discuss the local situation.
9. Discuss what would happen if everyone in your city had the dishwasher, clothes washer, lights, air-conditioner, T.V., and shower operating at the same time. (The demand on the generating capacity of the electric utility company would be so great that a "brown-out" or complete "black-out" might occur.)

Title: Locating Energy Industries

Purpose: To discover the issues involved when addressing problems of locating energy industries

Materials: Library time for students' research

Procedure:

1. Select a panel of students (6) for a role-playing activity. (Have one student act as Mayor or Chairman to conduct the meeting.)
2. Inform each student that he/she is a member of the Enersun (fictional town) city council.
3. They are to decide on a site and energy source for a new power plant to be built in their community.
4. Select four other students to represent neighborhoods in the eastern, western, northern, and southern sections of the city.
5. Select four other students to represent different interests wishing to have the new power plant use their preferred energy source: coal powered plant, nuclear powered plant, solar powered plant, and wind powered plant.
6. Other members of the class can act as concerned citizens of Enersun.
7. Conduct the meeting, giving everyone a chance to present his/her viewpoint.
8. Have the council vote on both issues.
9. Have students write a Letter to the Editor responding (pro or con) to the Council's decisions.

Title: What Is Safe?

Purpose: To involve the student in the complexities of finding a future energy source

Materials: Guest speakers from the various energy sources

Procedure: After discussing the advantages and disadvantages of different energy sources, the teacher should have arranged for guest speakers representing the energy sources listed in the table. Have each speaker defend his source as the future energy provider.

Advantages and Disadvantages of Different Energy Sources:

Energy Source

1. Coal

Advantages

- a. abundant source;
- b. technology developed.

Disadvantages

- a. mining coal harms environment;
- b. run-off may pollute water;
- c. deep mining dangerous for workers;
- d. restoring strip-mined land is slow, costly, not always successful;
- e. burning high-sulfur coal pollutes air.

2. Nuclear Fission

Advantages

- a. conserves oil and coal;
- b. little air and water pollution.

Disadvantages

- a. nuclear radiation, if leaked, may be fatal;
- b. problem of how to dispose of radioactive wastes;
- c. nuclear plants are expensive and time-consuming to build.
- d. waste containment and disposal are extremely expensive;
- e. radiation levels in wastes remain active and dangerous for centuries.

3. Nuclear Breeder Reactor

Advantages

- a. "Breeds" more fuel as it burns fuel, so fuel is theoretically inexhaustible

Disadvantages

- a. technology not commercially available;
- b. same (or more) radiation and waste-disposal problems as nuclear fission;
- c. since nuclear weapons can be made from its fuel, poses danger if sabotaged by terrorists.

4. Fusion

Advantages

- a. yields tremendous amount of energy as two atoms are forced to combine;
- b. byproducts have very low radioactivity, resulting in fewer problems with radiation and waste disposal than other nuclear sources;
- c. unlimited fuel source.

Disadvantages

- a. hard to control fusion process;
- b. not to be available before year 2000, if then.

5. Solar-Thermal

Advantages

- a. sun is an unlimited energy source, creates no harmful radiation or pollution;
- b. large areas of Earth get enough sunlight to use solar energy directly for buildings and power;
- c. technology now developed on small scale.

Disadvantages

- a. Low-cost technology not widely available before 1990;
- b. costly and inconvenient to convert buildings;
- c. solar energy difficult to store and transmit;
- d. would need backup energy system if solar storage depleted;
- e. not a dependable source in cloudy or cold climates.

6. Geothermal

Advantages

- a. untapped and extensive energy source;
- b. power plants take less time to build than coal or nuclear plants;
- c. technology already developed in individual cases on small scale.

Disadvantages

- a. technology not commercially available;
- b. "hot spots" of steam must be near Earth's surface to avoid need for complex plumbing;
- c. steam or hot water might contain polluting minerals, which would create disposal problems;
- d. Earth's surface might cave in if underground pressure is reduced.

Title: "Trade-Offs"

Purpose: To address the issue: Are Trade-offs Necessary?

Material: Copies of FEDERAL LANDS - UNTAPPED ESSENTIAL RESOURCES
(on next page)

Procedure:

1. Present to the students the article: FEDERAL LANDS - UNTAPPED ESSENTIAL RESOURCES by the American Petroleum Institute, Washington, D.C. 20037.
2. Ask this thought-provoking question: Do you see any trade-offs in usage of federal lands?
3. Are these trade-offs necessary?
4. Have each student bring in an article he/she believes exemplifies a trade-off.
5. Research the present national policy for leasing federal lands for oil exploration.
6. Identifying similarities and differences, compare the present administration's national energy policy with those recommendations proposed in this paper.
7. Why would the American Petroleum Institute be advocating leasing lands for oil exploration?
8. Do you agree with this paper Federal Lands - Untapped Essential Resources?
9. Have a class discussion (or formal debate) about the pros and cons of leasing federal lands for oil exploration.

Federal Lands-Untapped Essential Resources

The federal government owns about one-third of the land in the United States and all of the offshore area beyond state jurisdiction. The rich energy resources of these areas are indispensable in any effort to regain American energy security.

Government studies indicate that federal lands, including the Outer Continental Shelf (OCS), contain 37 percent of our undiscovered oil, 43 percent of our undiscovered natural gas and 40 percent of our remaining coal. But these lands now provide only 16 percent of U.S. oil production, 30 percent of natural gas production and 8 percent of coal production.

Obviously, everyone wants to preserve areas like the Grand Canyon and Yellowstone Park. But federal lands include much broader areas that do not have special scenic or historic value. These lands could contribute their full potential if more of them were explored for energy resources. However, exploration and development are prohibited or severely restricted on about two-thirds of the federal onshore lands. This is an area nearly five times the size of California. Offshore, less than 4 percent of the OCS has ever been leased.

These areas are off limits for several reasons. In some cases, federal laws directly prevent energy development, most kinds of recreation, timber harvest and many other activities by withdrawing lands from multiple use. In other cases, the laws do not withdraw the lands, but federal agencies have restricted or forbidden energy exploration and production. In still other cases, the executive branch has assigned land to restrictive categories such as national monuments, where energy development is not permitted.

Years of experience have shown us that we can both produce energy and preserve our nation's scenic beauty. To help us move toward both goals, the government can:

- o recognize energy production as one of the high priority uses for federal lands;
- o permit orderly access to federal lands for development of energy by responsible, competitive private companies; and
- o coordinate overlapping responsibilities and resolve contradictory regulations of the many agencies that manage federal lands.

More specifically, with regard to the Outer Continental Shelf, the government needs to simplify and speed up the entire offshore leasing and permitting process; schedule more lease sales, especially in Alaskan waters; lengthen the terms of leases to more than five years in certain frontier areas; and cut the time needed to prepare environmental impact statements and other reports.

Title: "Trade-Offs"

Purpose: To have students examine a process for evaluating energy-related matters.

Objectives: Students will be able to:

1. Define cost and benefit.
2. Explain how energy-related decisions involve costs and benefits.
3. Provide their own data in analyzing energy conservation measures using the cost-benefits model.
4. Assess the trade-offs involved in energy related decisions.

Materials: Student Handout, ENERGY ISSUES: COST AND BENEFITS (at the end of this lesson)
butcher paper
felt pens

Procedure:

1. Distribute handout, ENERGY ISSUES: COST AND BENEFITS.
2. Introduce students to the concepts cost and benefit explaining that for every decision related to energy, some groups benefit while others are hurt. The obvious example, OPEC's continued increases in the price of oil, has far-reaching effects upon all Americans. For most of us, it has been a cost, but there are some groups for which there have been benefits (i.e., bicycle manufacturers). Students can see more readily how our whole economy is affected by one decision when they analyze the costs and benefits to various populations.
3. Divide class into small groups, assigning each group an issue to analyze using the example provided. Allow ten minutes for brainstorming as students examine the costs, benefits, and overall effect on our energy supplies. The teacher should circulate during the brainstorming session, encouraging students to consider the impact of the decisions on various segments of the population. Students should record their data on butcher paper using the format of the model provided. Assign or allow students to select a recorder and spokesperson for their group.
4. Bring students together to share their analyses by having them tape their butcher paper to the blackboard. Allow students to walk around the room examining other groups' responses. Then have group leaders summarize their group's data.

GRADE 9, UNIT VII, LESSON 2
(Continued)

5. Assign individual research projects to students on energy issues that are somewhat more complex. Have them follow the same format in analyzing these issues:
 - a. Building a home with a passive solar heating system. If there are any solar heated homes in their community, students can visit these before preparing their report.
 - c. Call the local utility company to find out more about insulation, zero interest weatherization, rate structures, etc.
 - d. Interview a city council representative or state legislator to analyze a specific energy conservation proposal under consideration.
6. Have students analyze these energy decisions:
 - a. Mandatory weatherization of homes within a five-year period.
 - b. Riding mass transit.
 - c. Raising the driving age to 18.
 - d. Gas rationing -- 10 gallons a week/car.
 - e. Requiring people to live in the area where they work.
 - f. Cutting inter-school athletics (to save on fuel).
 - g. Requiring annual car engine tune-ups (to keep engines in peak energy efficient condition).

ENERGY ISSUES: COSTS AND BENEFITS (A MODEL)

Energy Issue: Increased Fuel Costs

WHO BENEFITS?

- OPEC?
- Oil Companies?
- Bicycle and moped manufacturers?
- Foreign and domestic small car manufacturers?
- The environment in terms of less pollution as a result of less mileage traveled by cars?

WHO IS HURT?

- The Consumer? Consider:
 - a. Increased income spent on fuel.
 - b. Increased cost of goods due to transportation and manufacturing costs.
 - c. Low income person has very limited mobility with high transportation costs.
 - d. Low income persons may have to keep their homes at low temperature levels in winter due to fuel costs.
- Large car manufacturers?
- Independent truckers, due to increased fuel costs which cut down on their profits?

HOW ARE ENERGY SUPPLIES AFFECTED?

- Higher costs will reduce consumption, thus stretching reserves.

Title: Energy And Civilization

Purpose: To read, interpret, and draw conclusions from prepared sources

Materials: Copies of: Graphs and QUESTIONS TO ACCOMPANY GRAPHS (on following pages)

Graph 1 - U.S. Production of Crude Oil and Total Consumption of Petroleum

Graph 2 - U.S. Oil Imports

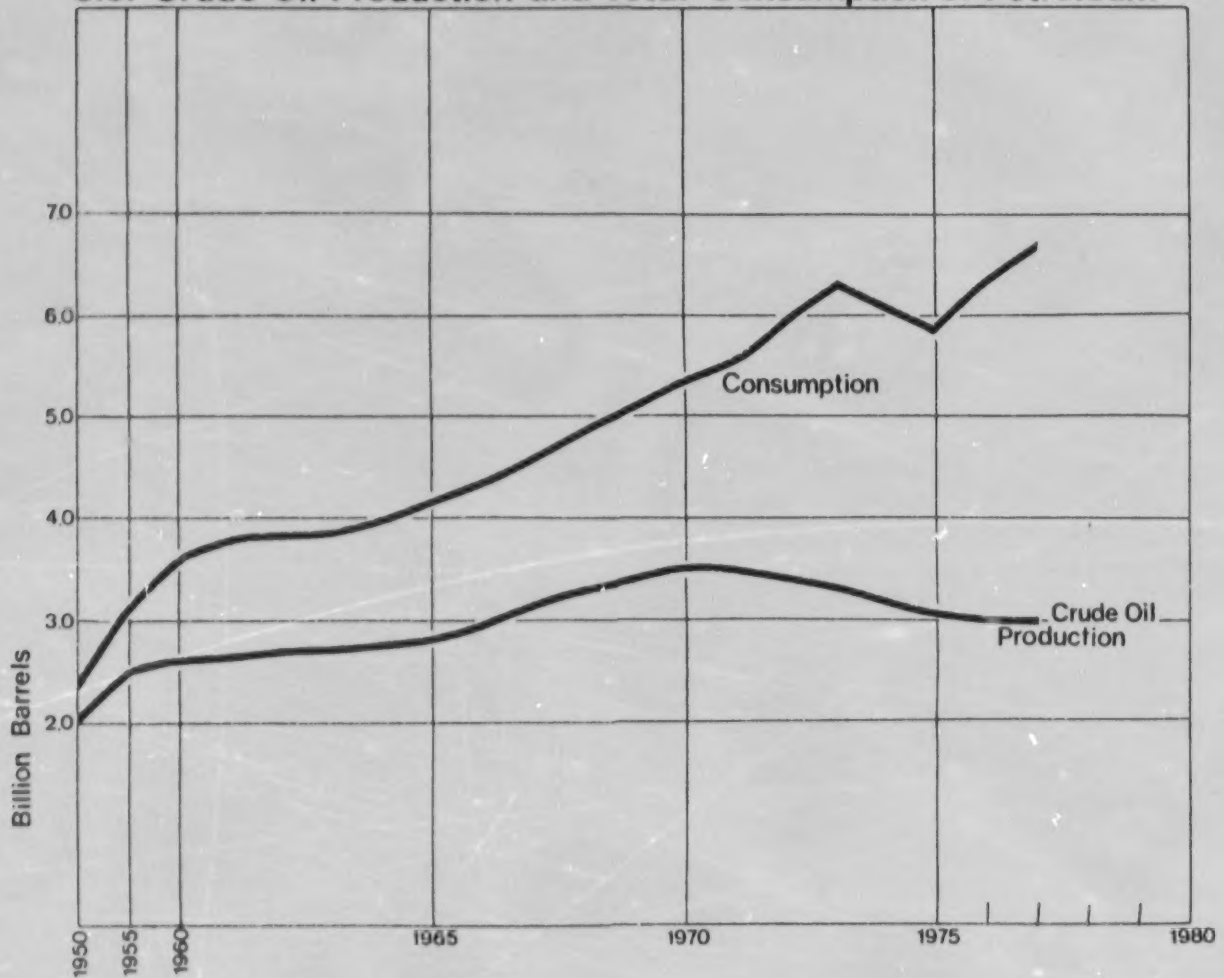
Graph 3 - Crude Oil Prices in Arabian and Persian Gulfs

Procedure:

1. Have students examine the graphs.
2. Then have them answer the questions. Questions 14, 15, and 16 can be handled as discussion questions.
3. Discuss this issue: Should we buy as much oil as we can, even at extremely high costs, and save our own petroleum until oil supplies from other countries are exhausted?
4. Why would Saudi Arabia wish to limit their oil exports, even though they are getting a high price for their oil?
5. Why would Saudi Arabia be developing solar power when they have a large petroleum supply?
6. Discuss the present Middle East situation.
7. Contact your local utility company or the Governor's Energy Office, in Tallahassee for latest statistics concerning production, consumption, imports, and prices of petroleum.
8. Add new information to the charts and discuss.

GRAPH 1

U.S. Crude Oil Production and Total Consumption of Petroleum

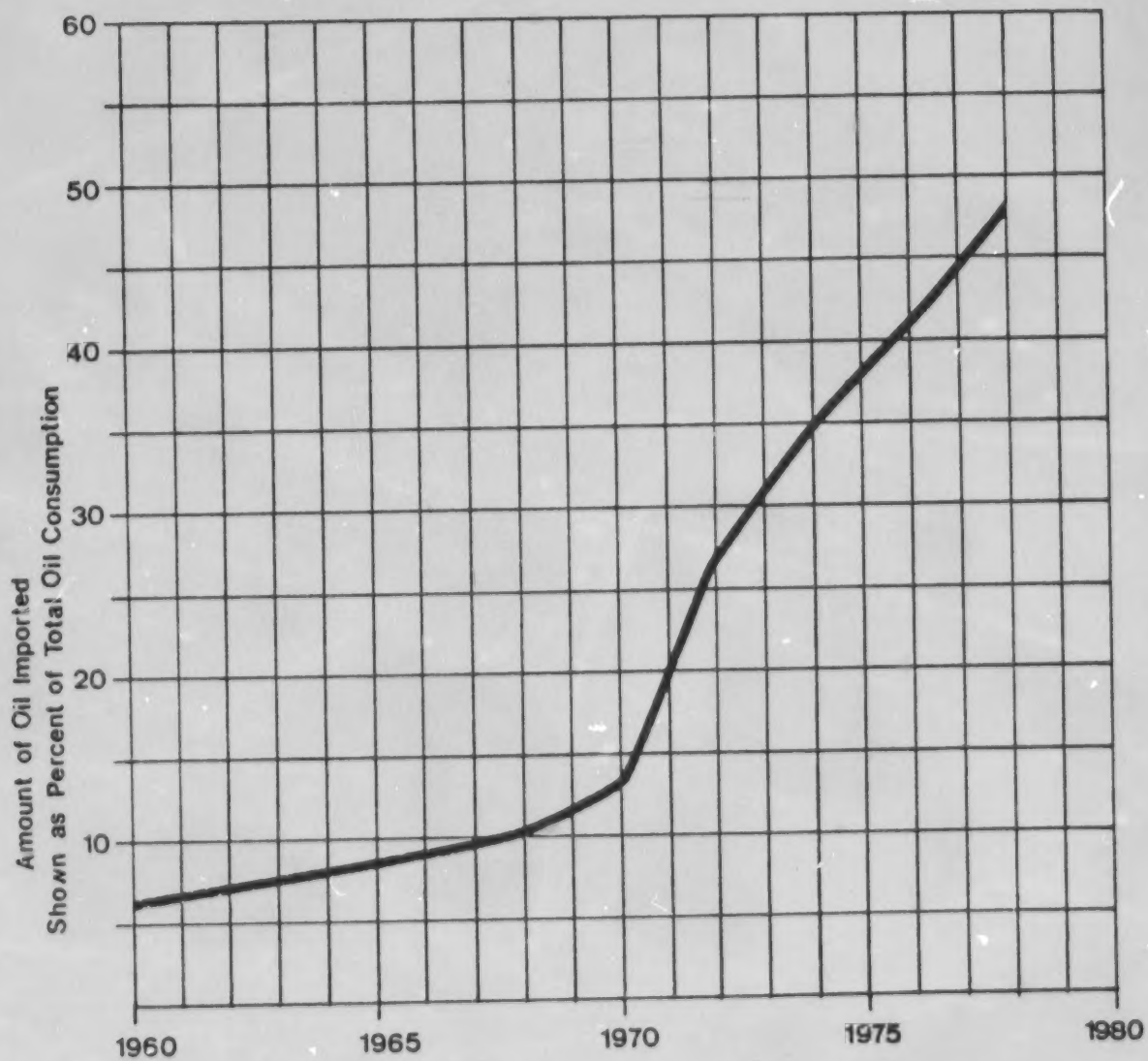


Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

GRAPH 2

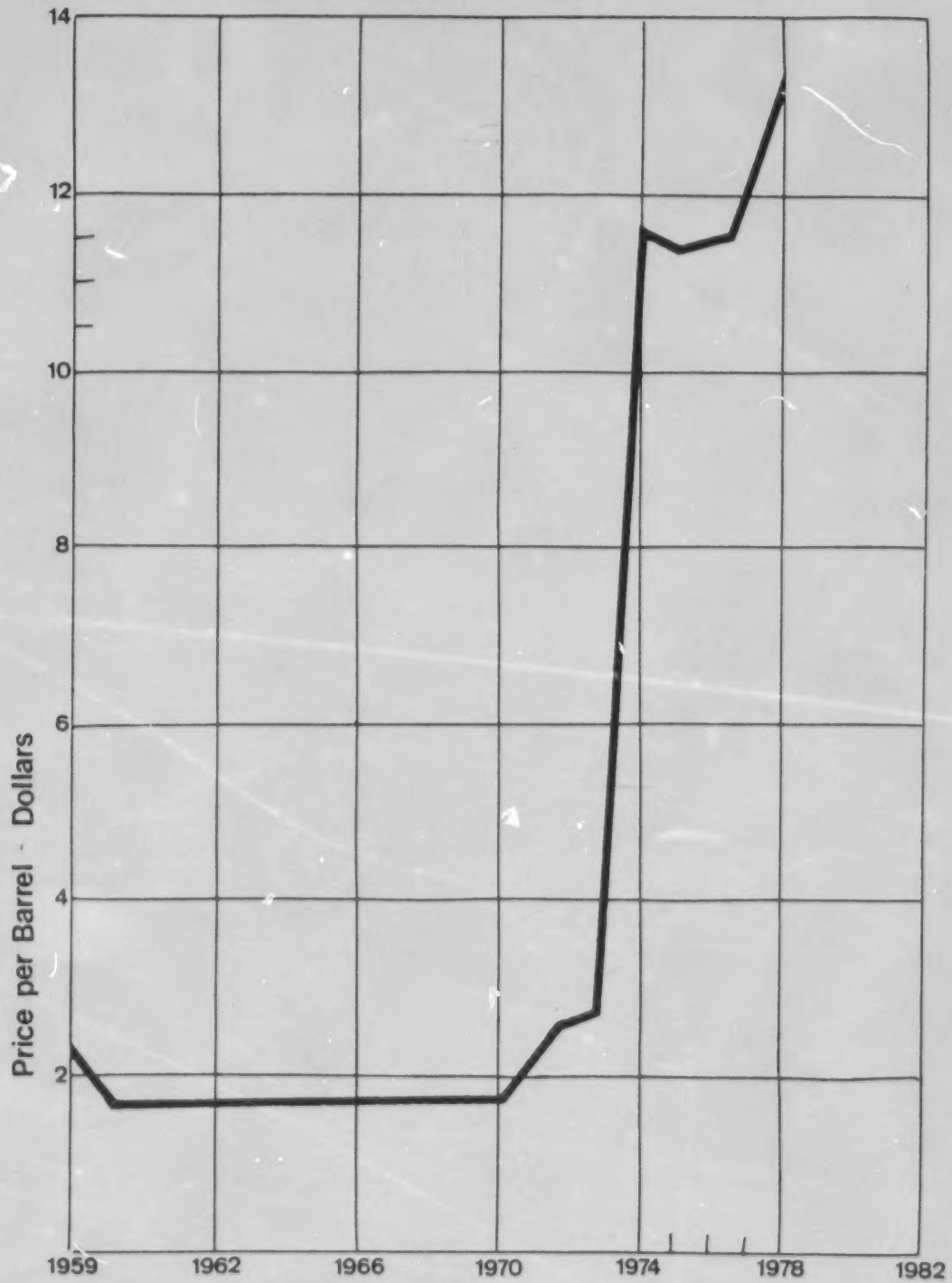
U.S. Oil Imports



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GRAPH 3

Crude Oil Prices in Arabian and Persian Gulfs



Questions to Accompany Graphs

1. What is the title of Graph #1?
2. What does the vertical axis show?
3. What does the horizontal axis show?
4. What is the time span of the graph?
5. What is the trend in total consumption?
6. What is the trend in crude oil production?
7. Between which years were total consumption and crude oil production growing at about the same rate?
8. In which years was total consumption more than twice as much as crude oil production?

Bonus Question

Where does oil come from that is not produced in the United States?

9. What does Graph #2 show?
10. What percent of the oil used in the United States in 1976 was imported?
11. What does this graph show about the relationship between U.S. production of crude oil and total consumption of petroleum?
12. Look at Graph #3. What can you learn from the graph?
13. Using the three graphs in this section, what reasons can you give for the rise in the price of Middle Eastern oil?
14. What effects do you think the rising price of oil will have on the U.S. culture and economy?
15. What effects do you think will occur in the U.S. if there were a complete embargo on Arab oil supplies?

Title: Energy And Civilization

Purpose: To have students hypothesize about some of the long term effects of energy decisions that could be made today

Objectives: Energy decisions made today will have multiple effects on the people and their lifestyles in the year 2000.

The student should be able to:

1. Trace the causes and effects of possible energy decisions.
2. Evaluate some of the trade-offs that must be made at the present time to insure an energy supply in the future.
3. Identify some of the reasons why it is difficult to plan for the future.

Procedure:

1. Write the POSSIBLE FUTURE ENERGY SITUATIONS (on the next page) on the chalkboard and have students copy each situation on separate pieces of paper. Divide the class into four large groups and give each group one possible future energy situation. This is passed from student to student, each one adding a one sentence consequence of the situation on the paper.
2. Encourage the students to build on what they already know about energy and on the original statement. These statements should be consequences the students think could be possible. For example, one answer for situation #1 could be: Everyone would starve to death.
3. Write one situation on the board and the students' proposed consequences. Discuss these possibilities with the students, evaluating the possible consequences. Could these really happen? Why or why not? What other events would need to occur in order for these events to happen?
4. An Alternative Plan: Write one situation on the board and have students volunteer consequences. Then discuss.

THE ENERGY FUTURE TODAY

Procedures

Is it difficult to think in terms of the future? Why? Why should we think about the future?

Can you think of some events of 10, 20, 30 years ago that have affected us positively? Negatively?

What is our impact on the future? Can we decide to have a certain kind of future and then make it happen? How? Should we?

Commentary

Major Point: By the types of decisions we make today, we can influence the type of lives we will have in the future. To some extent, the choice is between making the future or reacting to it.

POSSIBLE FUTURE ENERGY SITUATIONS

1. No decisions were made to increase the supply of energy.

Consequences:

2. Today the United States decided to invest all its energy money in developing solar power.

Consequences:

3. Today the United States decided to invest all its energy money in developing nuclear fusion.

Consequences:

4. Today the United States decided to invest all its energy money in increasing coal production.

Consequences:

5. Major conservation efforts were successful.

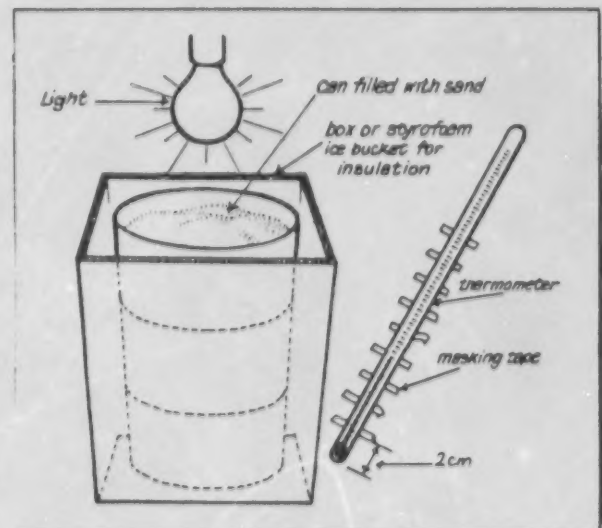
Title: Earth's Teakettle

Purpose: To demonstrate the energy potential of geothermal energy

Materials: Metal cans (gallon), sand, large light bulb or heat lamp, thermometer 0-110 degrees C and as long as the metal can, meter stick, box larger than can, tape and scissors, and a hot plate

Procedure:

1. Set up equipment as in the sketch.
2. Before class begins, heat the cans of sand on a hotplate for 5-10 minutes each to get the bottom sand to a temperature of between 75 degrees C and 100 degrees C. Put each can of hot sand in a box so that the students will not know it has been heated. Be sure that the can is not so hot that it scorches the box. You may want to wrap some cardboard or insulation around the bottom of the can so that the students do not discover that it has been heated. If this experiment is to be done in successive classes, some arrangement must be made to reheat the sand between classes.
3. Adjust the light-source so that it is about 30 cm above the sand.
4. Heat the sand for 15 minutes.
5. While sand is heating, start at the bulb end of the thermometer and, using a piece of masking tape, mark every 2 cm. Do not put the tape over the scale of the thermometer.
6. After 15 minutes, take the temperature of the sand at the surface; then the temperature 2 cm down; then 4 cm down; and so on to the bottom of the can.
7. Plot the depth and temperature on a graph.
8. Relate this activity to how the earth is functioning.



Title: Heat And Power From Solid Wastes

Purpose: To determine the composition of the average family's garbage

Materials: Average home's daily collection of garbage, bathroom scales

Procedure:

1. Have students bring in a normal day's garbage.
2. Separate a normal day's garbage into like types - foods, paper products, petroleum products, glass, and metals.
3. Determine the percent composition of the daily garbage by weighing each type of waste and comparing this to the total amount of garbage.
4. Set up a classroom chart and have each student record the total weight of the garbage in their home and the percentage of each type.
5. Discuss the most common types, and note the differences in kinds of garbage from families living in different areas.
6. Review where local garbage is normally disposed.
7. Discuss what wiser planning might do for our community (society).

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Title: Heat And Power From Solid Wastes

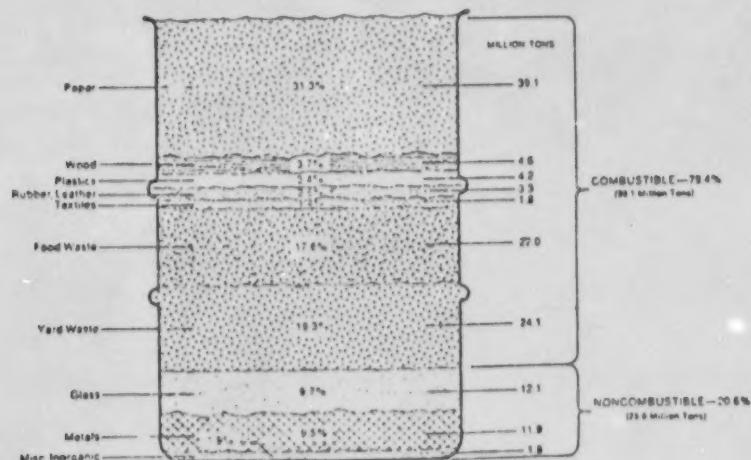
Purpose: To become more aware of energy-wasteful habits

Concept: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

Procedure:

1. Review with the class the general principal that energy is required to make all of the substances we throw away in our trash cans. Develop on the chalkboard (with input from students) a list of the substances commonly thrown into trash cans - paper, food wastes, glass containers, plastic wrapping materials, and others. Ask students to "guess" what substances comprise the major portions of solid waste found in the "National Trash Can."
2. Present, with use of an overhead projector, the figure below that shows the amount of various substances comprising the national trash can in 1971. Compare the data shown with their guesses.
3. Involve students in speculating whether the contents of the trash can have been changing since 1971. Why or why not? Ask each student to list on paper several things he and/or his family can do to reduce waste in two or three of the categories. Discuss individual responses in an effort to reach class consensus.
4. Contact the Environmental Protection Agency, Washington, D.C., for latest information.

National Trash Can
(Annual Municipal Solid Waste - 1971)



Source: Environmental Protection Agency, Second Report to Congress, Resource Recovery and Source Reduction, 1974

Title: Enhanced Recovery

Purpose: To show how thermal energy is being used to enhance recovery of oil reserves

Materials: Glass bowl, sand, plastic bag, 2 straws and honey. (rubber band, warm water)

Procedure:

1. Place a straw into a plastic bag into which you have placed a small amount of cool honey.
2. Close the bag around the straw, sealing it with the rubber band.
3. Place this apparatus into a bowl, straw pointing upward, and bury with sand to a depth of several inches.
4. Have a student attempt to suck the honey through the straw.
5. Now, insert the second straw into the sand and pour warm water down this straw.
6. Again, have the student try to suck the honey through the straw.
7. The students should now draw a parallel between oil and honey as demonstrated by this experiment.

Title: Fuels For The Future

Activity: Investigating the environmental problems associated with the development of synthetic fuels from coal

Purpose: To show that the costs of developing a useable fuel from coal is not just in the technology

Materials: Reading resources, newspapers and other news media

Procedure:

1. Determine where most of the people are located. (This is where the energy will be needed.)
2. Determine where the large, easy-to-recover coal deposits are located.
3. Determine the environmental impact of coal mining (strip and tunnels).
4. Determine the environmental impact of recovering the coal, converting the coal to a synthetic fuel, transporting the fuel and coal, waste disposal (ash, acids, etc.).
5. The students then should list all aspects of the "cost" of producing synthetic fuel from coal.

Title: Offshore Oil

Purpose: To gather and compile data, regarding attitudes of people toward offshore oil drilling and production.

Procedure:

1. Develop a short questionnaire that would gather information about:
 - a. Whether we need more energy.
 - b. What sources of energy are best.
 - c. Whether we should drill in Florida's offshore waters.
 - d. Whether you are willing to pay more for future energy wants.
 - e. The age group of the respondent.
 - f. Other questions that might be helpful.
2. Assign each student to interview other students, young adults out of school and older citizens.
3. Compile the data and report the information as a news release. (maybe through a local newspaper)

Title: Why More Power?

Purpose: To determine the amount of energy necessary to operate appliances and to become aware of the amount of energy (cost) used each time an appliance is in operation

Materials: "Watt Counter" also called the "Blue Box," and small appliances (hair dryers, fans, T.V., radio, etc.); anything that normally runs on 110 volts.

"Watt Counter" and teaching materials are available through your school district environmental/energy education contact person, your local utility company, or the Office of Energy and Environmental Education, Florida Department of Education, Tallahassee.

Procedure:

1. Show the cost of the energy being consumed by air conditioners and heaters when set at a "high" and a "low" setting.
2. Record the cost for appliances such as a refrigerator or stove and a light bulb.
3. Record the cost for some of your own appliances by plugging them into the "Watt Counter."
4. Discuss or list ways that you could save energy.
5. Plan a day of "Do Without." No hairdryers, T.V., etc. and discuss what it might be like if fossil fuels do become too expensive for the average homeowner.

Title: Why More Power?

Purpose: To observe energy usages in the home

Concept: Energy, its production, use, and conservation is essential in the maintenance of our society as we know it.

Materials: Copies of HOME USE ENERGY CHECK LIST (on following pages)

Procedure:

1. Have each student survey his home using the Home Use Energy Check List.
2. Have each student name the energy going into each item and the type of energy used in the end.
3. Use a collective procedure (involving responses from the entire class) and arrive at the frequencies at which various energy changes occur.
4. Make a graph that reflects the collective home energy usage information.
5. Have each student use his/her research to form a conclusion as to what energy transformations and forms are used most frequently.
6. Compare his findings with the home energy usage graph.

HOME USE AND ENERGY CHECK LIST

Name of Item Using Energy	Amount of Energy (Wattage) Required	Type of Energy Going into the Item	Type of Energy Being Used in the End	Number of Hours Used per Week	How Does It Help You?
Electric Radio					
Portable Radio					
Electric Can Opener					
Blender					
Range (stove)					
Refrigerator					
Dishwasher					
Mixer					
Hand-operated Can Opener					
Popcorn Popper					
Toaster					
Electric Skillet					
Food Grinder					
Waffle Iron					
Humidifier					
Telephone					
Lamp					
Television					
Toothbrush					
Pencil Sharpener					

HOME USE AND ENERGY CHECK LIST (Continued)

Hair Dryer					
Doorbell					
Vacuum Cleaner					
Furnace					
Water Heater					
Hand Saw					
Saber Saw					
Drill					
Sander					
Grill					
Porch Light					
Clock					
Sewing Machine					
Record Player					
Shoe Polisher					
Movie Camera					
Iron					
Candles					
Broom					
Washer					
Dryer					
Ceiling Light					
Fan					
Deepfreeze					
Mop					

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HOME USE AND ENERGY CHECK LIST (Continued)

[illegible]

Title: Synfuels

Activity: Produce gas from wood

Purpose: To show that gases can be driven from wood without burning the wood

Materials: Metal can that can be closed, metal tubing at least 18" long, ring stand, Bunsen burner and wood chips

Procedure:

1. Connect the metal tubing to the can. Have the end of the tubing slightly bent over the top rim of the can, with one or two inches of the tubing inside the can. Get assistance from the industrial arts department, if necessary.
2. Set up your apparatus, placing the can on the ring stand over the Bunsen burner.
3. Place the wood chips in the can and then close the can tightly over the top and around the tubing.
4. Start heating the can and watch for vapors coming through the tube. (Some of the vapor will be water, depending on how wet the chips were.)
5. Try to ignite the vapors. The vapors should ignite in a few minutes.
6. Relate what happened in this experiment to conversion of coal to synfuels.

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GRADE 10, UNIT III, LESSON 2

Title: Petrochemicals

Purpose: To show the dependency of American society on oil and its products

Procedure:

1. Compile a list of objects that normally might be found in a teenager's bedroom: record player, records, bed, mattress, covers, clothes, books, radio, clock, posters, carpet, paints, and so on.
2. Have each student check those articles that are in his/her room and then have them determine which are produced from petrochemicals.
3. Determine what would be left if we were to run out of oil, and then determine if or how they could be produced without petrochemicals.

GRADE 10, UNIT III, LESSON 2

Title: Petrochemicals

Purpose: To investigate the effects of oil-based industries on the present American culture; to read, interpret and draw conclusions from prepared sources

Materials: Copies of OIL-BASED PRODUCTS (on next page)

Procedure:

1. Ask students to name things that are made from petroleum.
2. List these on the board.
3. Distribute copies of the list of products related to oil. Allow enough time for the class to examine the list.
4. Working alone or in small groups, have students categorize the items as necessities or luxuries.
5. After the students have categorized the items, tell them that the amount of oil available in the country has been cut in half. They must eliminate half of the items on the list.
6. After they have done this, ask them how they decided which items to cut from the list. What did they consider absolute necessities? What did they consider luxuries? Why do students have different answers?

OIL-BASED PRODUCTS

antenna cable
credit cards
permanent-press clothes
heart valves
disposable diapers
telephones
enamel paint
vinyl siding
safety flares
bubble bath
bookends
deodorant
panty hose
bedspreads
plastic tubs
lunch boxes
jerseys
windshield wipers
phonographs
garment bags
fences
kitchen counter tops
pillows
dune buggy bodies
checkers
soap dishes
syringes
shoes
volley balls
sleeping bags
electrician's tape
mascara
flags
oxygen masks
ink
hair spray
steering wheels
food wraps
rubber duckies
seed tape

card tables
ping pong paddles
purses
weed killers
puzzles
dishdrainers
puppets
hearing aids
earphones
whistles
clothesline
carpet sweepers
chess boards
yardsticks
slip covers
mats
refrigerator linings
floor wax
panelling
false eyelashes
no-wax floors
golf balls
lighter fluid
attache' cases
wet suits
laxatives
trash cans
brassieres
acrylic paints
vacuum bottles
bearing grease
rafts
sockets
tiles
air-conditioners
wallets
backpacks
rubbing alcohol
epoxy glue
oil filters

Title: Wasted Waterpower

Purpose: To design and build a model of a "low head" hydro generating plant to learn about the necessary components in an electrical power generating system

Materials: 2 large buckets, plastic tubing, a propeller (such as in hair dryer), a small electrical motor, electrical wire, and a light bulb.

Procedure:

1. Design a situation in which water will run across the propeller shaft that has been fitted to the shaft of the electrical motor.
2. The motor should then be wired through a switch (break in the wire) to the light bulb.
3. Each student should be able to describe the components of the system (Energy Source), converting mechanical energy into electrical energy, the transportation system of the electricity, and how energy gets to the consumer.

Title: "Ouroboros"

Purpose: To build several passive home heating systems to compare various methods of collecting and using solar heat

Materials: Will vary - small boxes, transparent material such as saran wrap, sand, soft drink cans, paint, etc.

(You might wish to contact the Florida Solar Energy Center, Cape Canaveral, for passive solar designs and information.)

Procedure:

1. Have the students read articles on passive heating plans from magazines such as Popular Science and Mother Earth News.
2. Have teams select, modify and build a passive heating system.
3. Each team will report the strengths of their design and its feasibility in Florida.
4. You may wish to contact your local Home Builders Association for assistance or to request that a builder specializing in passive design construction meet with your class to comment on student's designs.
5. Another source of assistance would be a local architect or a professor from a university school of architecture.

GRADE 10, UNIT IV, LESSON 2

Title: Solar Satellites

Purpose: To investigate the advantages of transmitting microwave power from space to earth and to study the practicality of a satellite power station

Materials: Resources such as current magazines and literature from the U.S. Government (NASA)

Procedure:

1. Have the students read several articles on a solar power system.
2. Discuss the strengths of such a plan and some of the more apparent problems such a venture might be confronted with.
3. Have each student give a one minute talk - either supporting or opposing such a commitment.

GRADE 10, UNIT IV, LESSON 3

Title: Power From Thin Air

Purpose: To discover the course of winds and to discover what produces winds

Materials: Resource books - science books, library books on weather

Procedure:

1. Discuss the earth's rotation and the effects of the sun on land and water masses as they are heated and cooled.
2. Have the students research trade winds, the jet streams, hurricanes and weather.
3. Discuss winds as a source of power.
4. Locate on a map of the United States where wind power would be a potential source of substantial power.

Title: Florida Energy Profiles

Purpose: To stress the importance of gasoline in our daily lives and changes we may need to make

Materials: Handout, YOU AND THE PRICE OF GAS (on the next page)

Procedure:

1. Distribute YOU AND THE PRICE OF GAS.
2. Give the students time to answer the questions.
3. You may want to ask these questions:
 - a. Which decisions were easy to make? Hard to make?
 - b. Can you think of any reasons why the price of gasoline should rise? (To get the public to use less energy. Gas companies may make a greater profit and thus be able to find other sources of energy.)
 - c. Would some groups of people have a more difficult time than others if the price of gas went up? (In general, the poor person will be affected by a price increase the most.)
 - d. What suggestions can you think of to curtail the use of gasoline? (rationing; building more public transportation; closing gas stations on weekends; selling gas to certain individuals only on designated days, e.g., odd license plates on odd days only)

YOU AND THE PRICE OF GAS

As demand for energy increases, the price of energy also may go up. This price rise will happen if the supply of energy remains the same or increases more slowly than the demand for energy.

Some economists predicted in 1970 that the price of gasoline would increase to over a dollar per gallon. In some countries people already pay over two dollars for a gallon of gas. What is the price of gasoline in your town now?

List five different ways your family uses a car.

- 1.
- 2.
- 3.
- 4.
- 5.

Which of these uses of the car would your family stop if the price of gas rose to:

- \$1.75
- \$2.00
- \$3.00

At what price would your family stop using a car?

If your family were very much richer than it is, would your decisions be different?

If your family were very much poorer, would your decisions be different?

What factors, other than price, influence how your family uses the car? For example - the nearness to public transportation.

What would you do differently if there was a gasoline shortage? How would the shortage affect your family and town?

Title: Appliance Labeling

Purpose: To consider how one could save energy by purchasing more efficient appliances

Materials: Copies of HOW TO FIGURE WHETHER THE ENERGY EFFICIENT MODEL IS A BETTER BUY FOR YOU and the ENERGYGUIDES, MODEL A and MODEL B for each student (on following pages)

Procedure:

1. Explain to the students how to figure whether an energy efficient model is a better buy by going through the five steps with the energyguides for Model A and Model B.
2. Have students go to a local appliance store and make comparisons of appliances using the handout "How To Figure Whether the Energy Efficient Model is a Better Buy for You."
3. The student can use the energy cost information on the label to determine which appliance costs less to run and whether he/she is better off buying an appliance with a higher initial purchase price but lower annual energy cost.
4. Have students try comparing two appliances found in the marketplace. Remembering: with clothes washers, dishwashers, and room air conditioners, all of which do not run continuously, the student will need to know both the local energy rate and how often the appliance is used before they can identify their yearly operating costs.

HOW TO FIGURE WHETHER THE ENERGY EFFICIENT MODEL IS A BETTER BUY FOR YOU

	Model B Standard Model	Model A Energy- Efficient Model	Difference
Step 1. Purchase Price	\$ _____	\$ _____	\$ _____
Step 2. Yearly Cost (from appliance label)	\$ _____	\$ _____	\$ _____
Step 3. How many years do you expect to keep it?	_____ yrs.	_____ yrs.	0
Total Operating Cost (Multiply Yearly Cost by number of years you will keep it)	\$ _____	\$ _____	\$ _____
Step 4. Total cost to you (Add Purchase Price and Total Operating Price)	\$ _____	\$ _____	\$ _____
Step 5. To figure how long it will take to recover the extra cost of the energy efficient model, divide the difference in price from line 1 by the difference in yearly operating cost from line 2.			
Difference in purchase price - Difference in yearly cost = Years to Recover			
\$ _____ - \$ _____ = _____ yrs.			

The average life expectancy of new appliances are:

Refrigerators and Refrigerator-Freezers	15 years
Freezers	18-20 years
Dishwashers	11 years
Clothes Washers	11 years
Water Heaters	10-12 years
Room Air Conditioners	12-15 years
Furnaces	20 years

MODEL A
Cost: \$545.00

Refrigerator-Freezer
Capacity: 17 Cubic Feet

(Name of Corporation)
Model(s) F117, F317
Type of Defrost: Full Automatic

ENERGYGUIDE

Estimates on the scale are based
on a national average electric
rate of 4.97¢ per kilowatt hour

Only models with 16.5 to 18.4
cubic feet are compared
in the scale

Model with
lowest
energy cost
\$50

\$51

THIS MODEL

Model with
highest
energy cost
\$88

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

Yearly cost	
Estimated yearly \$ cost shown below	
Cost per kilowatt hour	2¢ \$21
	4¢ \$41
	6¢ \$62
	8¢ \$82
	10¢ \$103
	12¢ \$124

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.

Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302)

(Part No. 371026)

MODEL B
Cost: \$485.00

Refrigerator-Freezer
Capacity: 17 Cubic Feet

(Name of Corporation)
Model(s) AH503, AH504, AH507
Type of Defrost: Full Automatic

ENERGYGUIDE

Estimates on the scale are based
on a national average electric
rate of 4.97¢ per kilowatt hour

Only models with 16.5 to 18.4
cubic feet are compared
in the scale

Model with
lowest
energy cost
\$50

\$70

THIS MODEL

Model with
highest
energy cost
\$88

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

Yearly cost	
Estimated yearly \$ cost shown below	
Cost per kilowatt hour	2¢ \$28
	4¢ \$57
	6¢ \$85
	8¢ \$113
	10¢ \$142
	12¢ \$170

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.

Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302)

(Part No. 371026)

Title: Rapid Transit

Purpose: To discover some of the advantages of urban mass transportation systems

Materials: Transparency or copies of GETTING THERE for each student and Student Questions (on following pages)

Procedure:

1. Explain the concept of passenger miles per gallon. This is a term that refers to the number of people that can be carried by an amount of fuel for one mile. This will help the student consider the relationship between the single-passenger car and efficiency. Distribute GETTING THERE. Then answer the questions for each table.
2. Discuss these key ideas:
 - a. Mass transit types of transportation are energy efficient only when they are running with full passenger loads.
 - b. People will not use mass transit until they can save money and the mass transit means of transportation is convenient.
 - c. Some ways of encouraging use of mass transit are to: raise parking fees, reduce the number of parking lots, partially subsidize bus and train costs, and supply fleets of minibuses.
 - d. Door-to-door convenience must be provided to attract passengers and discourage the use of the private automobile.
3. Discuss transportation systems available in your local city, town, or community.
4. Discuss the feasibility of new systems for your locality.

GETTING THERE

Table I

TYPES OF URBAN TRANSPORTATION	FUEL MILEAGE (AVERAGE) (MPG = Miles Per Gallon)
Automobile	18 MPG
Van	16 MPG
Bus	3.3 MPG
Commuter Train	.1 MPG
DC Jet	.25 MPG

Table II

Forms of Trans- portation	Number of People	MPG	Fuel Needed for 20-Mile Trip (In Gallons)	Fuel Per Person (PMPG)
Car	1	18	1.11	1.11
Car	2	18	1.11	.56
Car	4	18	1.11	.28
Van	1	16	1.25	1.25
Van	2	16	1.25	.630
Van	8	16	1.25	.165
Bus	5	3.3	5.1	1.2
Bus	20	3.3	6.1	.31
Bus	40	3.3	6.1	.15
Train	1,000	.1	200	.20
Airplane	100	.25	80	.80

Remember: Passenger miles per gallon is arrived at by dividing the number of people into the amount of fuel used.

Student Questions

Table I

1. Which type of urban transportation listed on Table 1 gets the most miles from each gallon of fuel?

Table II

2. Which vehicle gets the most miles per gallon (MPG)?
3. Which uses the most fuel for a 20-mile trip into the city?
4. Which uses the most fuel per person for a 20-mile trip into the city?
5. Which uses the least amount of fuel per person for this trip?
6. If the 1000 people who rode on the commuter train drove a car to the city instead, how much additional fuel would be used?
7. How much fuel is saved by having 40 people ride a bus instead of using 20 cars with two people in each car?

Write a summary paragraph for each question below.

- a. Are mass transit systems, like buses and commuter trains, always more efficient than cars? Explain.
- b. Suppose the mayor of your city appointed you as the new director of mass transit systems. He or she wants your ideas on the serious problems of too many cars in the city and the underused public transportation facilities. What would you say in a letter to the mayor? at a public meeting?

Title: "Drain America First"

Purpose: To emphasize the government's role in fuel shortage crises

Materials: Library time for students

Procedure:

1. Select a few students to research an energy shortage similar to fuel shortages. Some examples are:
 - a. The Oil Embargo of 1973;
 - b. Fuel Shortages during World War II;
 - c. Natural Gas Shortages of 1976-77; and
 - d. Coal Strike of 1978.
2. Have the students include in their reports the causes and effects of the crisis.
3. Answer these questions:
 - a. How did people cope with the shortage?
 - b. What government actions, if any, took place?

Title: "Drain America First"

Purpose: To investigate alternative methods of distributing energy sources

Objectives: Students should be able to:

1. List alternative methods of distributing global energy resources.
2. Identify the methods of distribution that are currently in practice and suggest reasons for each method.
3. Identify the global inequities of energy resource distribution.
4. State that distributing energy resources equitably is complex and difficult.

Materials: Hungry students, one small pizza (6"), (optional: 9 paper bags, felt pens)

Procedure:

1. Say: We will use a pizza to examine the inequities in the distribution of energy resources on a global (classroom) level. We will discuss alternative methods of distribution as we wrestle with the issue of how to slice the pie.
2. Write this question on the board: How should energy resources be distributed?
3. At the teacher's discretion, this activity can be introduced in several ways:
 - a. Dramatic Presentation: Place a small pizza on someone's desk. Obtain nine grocery bags. Draw a face on each bag. Place one of the proposals (listed below) in each bag. "Introduce" each "candidate" to the class; reading his/her proposal for allocating the world's energy supplies.
 - b. A second method is to list the proposals given below on the board with the question: How should global energy resources be allocated?
4. Regardless of the method chosen, students are to pick an alternative for distribution of global energy resources. This can be an individual task during which students "vote" for a candidate (proposal) of their choice. Or teachers may choose to divide the class into small groups to promote student interaction.

Note: Watch out!! Some students may become frustrated waiting for their share. Some have stolen the food supply and actually taken a bite out of the pizza in full view of other classmates. If this occurs, the implications for discussion are many. How long can developing nations wait for answers to energy distribution?

Methods for distributing the pizza include:

1. Sell to the highest bidder.
2. Divide it equally.
3. Save it for a rainy day.
4. Give to the people with the highest grades.
5. Award to the people who have worked the hardest in the class.
6. Give it to the neediest people.
7. Award it to the people who have contributed the most in class.
8. "First come, first serve."
9. Give it to the student whose desk it is on.
10. Give it to the strongest.

CONCLUDING
THE LESSON:

Ask students:

1. Given the state of world energy supplies, which proposal(s) do you think are totally impossible. Why?

(Possible student responses: If resources were divided equally, no one nation would get the energy it needs; it's too late, the rainy day has arrived.)

2. Given the state of the world's energy supplies, which proposal(s) do you think explain our current global energy situation? Defend your answers.

(Possible student responses:

- #1 - Obvious, OPEC's price tactics;
- #4 - Depending on students perception "high grades" may be interpreted as "high technology."
- #5 - Other students may interpret our high technology as "hard work."
- #6 - Foreign aid and investments will probably be seen as our contributions, providing one rationale for consumptive patterns among developed nations.
- #7 - Since we've already developed, we're first in line.
- #8 - Using the Middle East as an example, students can probably justify this proposal.)

GRADE 10, UNIT VI, LESSON 1
(Continued)

3. Given the state of world energy supplies, which proposals would be the most difficult to implement? Defend your answers.

(Student responses will vary. Reaching consensus on criteria such as "high grades," "hard workers," "neediest" and "contributors" is a difficult task.)

4. Which method(s) of distribution seem the most equitable? Which seem the least equitable?

(Responses will vary. Students should cite their reasons.)

5. Could some methods lead to conflict?

(Most could -- have students support their responses.)

EXTENDING THE LESSON

1. As a research project, have students obtain the data necessary to translate the "pizza" into a circle graph illustrating consumption patterns of countries.
2. Have students become "campaign managers" urging support for candidates representing each proposal.
3. Set up a role-reversal. How would a Nigerian, Indian, or Brazilian student respond to each proposal?
4. Allow students to select and prove how one or two of the proposals are in practice today. This option requires further research.
5. In many ways, each proposal in this activity represents a different ideology. Students who have some background in comparative governments might enjoy trying to identify the best examples of the following economic systems:
 - a. Communism, (command economy) - Divide it equally.
 - b. Capitalism (market economy) - Sell to the highest bidder, or first come, first serve.

Title: Are We Running Out Of Energy?

Purpose: To explore the question "Why don't we conserve?"

Procedure:

1. Explain to the class that decisions must be made to conserve energy - that's where we ran into so much trouble when we did not believe there were limits to our fossil fuel supplies.
2. Explain that these decisions are based on knowledge, attitude, cost, and government sanctions and technology.
3. Have students quickly examine the following energy quotes:
Energy For a Strong America;
Bigger is Better;
Here Comes the Sun;
Live Better Electrically;
Take a Bus and Leave the Driving to Us;
Keep off the Gas;
When not in Use, Save the Juice (electrical);
Pool It, Don't Be Fuelish; and
Progress is Our Most Important Product.
4. Sort the quotes into those that may encourage the use of energy and those that may encourage the conservation of energy.
5. Have students bring in other types of advertising seen on T.V., in the paper, in magazines, or heard on the radio that might encourage the use of energy or the conservation of energy.

Title: Florida -- The End Of The Energy Pipe

Purpose: To involve the student in thinking about alternative energy sources and methods of use in Florida

Procedure:

1. Have the students draw a cartoon showing how they think Floridians should deal with the scarcity of fossil fuels.
2. Ask these questions as each cartoon is presented to the class:
 - a. How does this cartoon deal with scarcity?
 - b. What change did the people make?
 - c. Would people make these changes voluntarily? Why or why not?
 - d. What is the cartoonist's attitude toward dealing with the scarcity?
 - e. Is it shown in the cartoon? How do you know?

Title: Energy And Clean Air

Purpose: To understand the effects of coal production on the environment

Procedure:

1. Present this issue to the class:

The United States must make some major decisions about energy for the near future. Many experts point out that the demand for energy is growing faster than the supply. This scarcity for energy will create serious problems. Assume that you are advisor to the President. The President wants to know if the nation should increase its production of coal. To make a good decision, the President must know some of the benefits and some of the costs of increased coal production.

2. Say: Go home tonight and list five costs and five benefits of coal production. Remember that costs and benefits include not only money but changes in numbers of jobs, foreign relations, working and living conditions.
3. The next day, have each student look back at the costs and benefits and put a star before the most serious cost and the most important benefit. Is the benefit worth the cost?

Title: Energy And Clean Water

Purpose: To understand the effects of oil transport on marine life

Materials: Transparency of DISTRIBUTION OF GLOBAL OIL RESERVES or copy the information on the chalkboard

Procedure:

1. Discuss with your class the distribution of global oil reserves, as estimated by the Oil and Gas Journal in January 1978.

DISTRIBUTION OF GLOBAL OIL RESERVES

	Reserves % of World Total	Consumption
North America	6	34
Latin America	6	6
West Europe	4	24
Eastern Europe	12	16
Middle East	57	2
South Asia	1	1
Far East and Oceania	5	15
Africa	9	2

Looking at the distribution, one immediately sees that concentration of oil reserves is far from the main consumers. This fact greatly increases transportation problems and the risks of spills and marine pollution.

2. Have the class investigate the effects of oil spills on sea life.

Title: Oil Rigs And Marine Life

Purpose: To understand the environmental effects of offshore oil drilling and production

Procedure:

1. Divide the class into two sections:

- a. the offshore oil drillers, and
- b. the marine ecologists.

2. Debate the question:

Offshore Oil Drilling - Power

or

Offshore Ecology = Saving the Sea Life

VOCABULARY - "ENERWORDS"

Ampere - A unit of measure for electric current.

Appliance - A device which does a special job, usually electric.

Barrel - A liquid measure of oil, usually crude oil, equal to 42 gallons or 306 pounds.

Bituminous Coal - Soft coal, high in volatile matter.

British Thermal Unit (BTU) - A unit of heat energy - the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit.

Brownout - The lowering of power supplied to customers by a power company when power demand exceeds generating capacity.

Calorie - A unit of heat equal to the amount of heat necessary to raise the temperature of one kilogram of water one degree Celsius; equal to 1000 small calories.

Carbon Dioxide - A compound of carbon and oxygen formed when carbon or carbon materials are burned or used in the body.

Carbon Monoxide - A compound of carbon and oxygen formed when carbon or carbon materials are incompletely burned. When formed in automobiles, it becomes a major air pollutant.

Catalytic Converter - A device placed on the exhaust of an automobile that changes carbon monoxide and hydrocarbons, which cause air pollution, to carbon dioxide and water.

Centigrade - See Celsius.

Celsius - A temperature scale which runs from zero degrees (the temperature of melting ice) to one hundred degrees (the temperature of boiling water). Sometimes called centigrade.

Charcoal - A porous, solid residue resulting from the incomplete combustion of wood or bone.

Chemical Energy - Energy stored in the structure of atoms and molecules, which can be released by a chemical reaction.

Clean Fuel - A low sulfur fuel.

Coal - A solid organic material formed by the decomposition of plant material without air, containing 75% carbon.

Coal Gas - "Fuel gas," the gas formed when coal is partially burned to make coke. Has 1/3 the energy of natural gas.

Coal Gasification - The process which converts coal to a gas.

Coal Liquification - The process which converts coal to a liquid fuel by the addition of hydrogen.

Coal Tar - A black, gummy substance produced when coal is distilled.

Coke - A porous, solid residue resulting from the incomplete combustion of coal heated in an oven with a limited supply of air. A good fuel, more nearly pure carbon than coal.

Combustion - Burning, a chemical reaction producing heat and light and, in some cases, a flame. Usually a combination of carbon and oxygen.

Conduction - The transmission of energy directly from one substance or molecule to another.

Conserve - To keep from being lost, wasted, or damaged.

Convection - The transfer of energy by moving masses of liquid or gases.

Conversion - The process by which energy is changed from one form to another.

Cooling Tower - A structure for cooling waste water from power plants.

Cord - A measure of wood volume - a stack four feet by four feet by eight feet.

Cracking - The process of breaking down the molecular structure of heavy hydrocarbons into lighter hydrocarbons, as when gasoline is produced from crude oil.

Crude Oil - A mixture of hydrocarbons in liquid form found in underground reservoirs; the raw material from which most refined petroleum products are made.

Depletion Allowance - A tax exemption for a portion of the revenue received from depleting a natural energy resource (e.g., removing oil from a well).

Dry Steam - Steam so hot it contains no water droplets.

Ecology - The study of relationships between living things and their environment.

Efficiency - The ratio of the work or energy output to the energy input to do the work.

Electric current - A flow of charged particles, usually electrons.

Electrons - Negatively charged particles that orbit the nucleus of an atom. A chemical reaction consists of the transfer and rearrangement of electrons between atoms.

Electrostatic Precipitator - A device that removes waste particles from the exhaust of power plants by attracting them to electrically charged plates from which they can be washed away, thus preventing air pollution.

Energy - The ability to do work; to move a force a certain distance. It exists in many forms and can be converted from one form to another.

Energy Density - The energy per unit of weight in a fuel.

Energy Intensiveness - A measure of energy utilization. For example, the number of calories used to move a passenger one mile.

Environment - Everything that is not you - and you.

Environmental Impact Statement - A predicted analysis of the impact on the environment of a projected activity. For example, the mining of coal, or offshore drilling for oil.

Fahrenheit - A temperature scale which uses 32 degrees as the melting point of ice and 212 degrees as the boiling point of water, named after its inventor.

First Law of Thermodynamics - The law of conservation of energy, which states that energy can neither be created nor destroyed.

Fission - The splitting of atoms (heavy nuclei) to release energy.

Food - The fuel used by animals, including man, to produce "body power."

Food Chain - The pathway over which any food material passes from the producing organism to consuming organisms.

Force - The power exerted on an object to produce motion or change of direction.

Fossil Fuel - A natural fuel such as coal, oil, or natural gas, formed from the fossil remains of living things.

Fuel - A substance that can be burned to produce heat.

Fusion - The joining together of atoms to release energy.

Gasoline - A fuel composed primarily of light hydrocarbons, produced by "cracking" crude oil in a refinery.

Generator - A device which produces electric energy from mechanical energy, as in a motor or water turbine.

Geothermal Energy - Heat energy within the earth which produces steam when it comes in contact with water.

Geyser - A spring from which hot water and steam shoot into the air.

Greenhouse Effect - The warming effect of the carbon dioxide in the atmosphere which allows solar radiation to reach the earth but which absorbs (and keeps in) the heat radiation from the earth.

Harness - To control so as to use the power of, as of steam.

Heat - A form of kinetic energy resulting from the movement of molecules in matter. It flows from one body to another if there is a temperature difference between them.

Heat Engine - A device which converts heat energy into mechanical energy.

Heat Pump - A device which transfers heat from one place to another by using electric or mechanical energy. It can pump warm air into a building to heat it, or out of a building to cool it.

Heat Sink - Any substance that absorbs waste heat - air, water, or space.

Heat Tax - The heat energy that is lost when energy is converted from one form to another.

Horsepower - A unit of power equal to 746 watts.

Hydrocarbons - Molecules made up of hydrogen and carbon atoms in various proportions, usually formed by living things.

Hydroelectric Plant - An electric power plant in which electricity is generated by using the energy of falling water to turn turbines.

Indirect Energy - Any form of energy used to provide goods and services, which themselves may or may not use energy.

Joule - A unit of energy or work; the amount produced by a force of one newton operating through the distance of one meter, named after its inventor.

Kerosene - A fuel used in jet engines and gas turbines, made up of a mixture of hydrocarbons by "cracking" crude oil in a refinery. Its hydrocarbons are heavier than those in gasoline or naphtha.

Kilowatt - A unit of electric power equal to 1000 watts.

Kilowatt-hour - A unit of energy or work equal to the use of one kilowatt of energy for one hour.

Kinetic Energy - The energy of motion; the ability of an object to do work because of its motion.

Laser - A device which can produce high intensity radiation by forcing the atoms or molecules in a material to radiate at the same time, rather than independently, as in a light bulb.

Light - Electromagnetic radiation which can affect the eye.

Light Water Reactor - A nuclear reactor in which water is the primary coolant or moderator.

Liquefied Natural Gas (LNG) - Natural gas that has been turned to a liquid by cooling it to minus 160 degrees Celsius, thus reducing its volume and making it easier and cheaper, and probably more dangerous, to store and ship.

Machine - A device which uses energy to do work.

Mechanical Energy - A form of energy which is seen as the motion of an object.

Megawatt - A unit of power equal to 1000 kilowatts or one million watts.

Moderator - The material (water, graphite, etc.) used in a nuclear reactor to control the rate of fission.

Natural Gas - A natural mixture of hydrocarbons found in porous rocks under the earth's surface, usually in association with petroleum. It is almost pure methane.

Non-renewable - Not able to be replaced once used up, as oil.

Nuclear Energy - Atomic energy, the energy released by changes in the nucleus of an atom in a reactor.

Nucleus - The dense, positively charged core of an atom.

Off-peak Power - Power generated during a period of low demand.

Oil Shale - A sedimentary rock containing the material kerogen, which can be recovered as oil when the rock is heated at high temperatures.

Particulates - Small ash and soot particles produced in burning.

Peak Load - The maximum amount of power which a plant can produce in a given period of time.

Petrochemicals - Chemicals derived from petroleum.

Petroleum - An oily, flammable liquid mixture of hydrocarbons that may vary from almost colorless to black, found in sedimentary rocks, and providing the raw material for a host of fuels and synthetic materials.

Photosynthesis - The process by which green plants convert the radiant energy of the sun into chemical potential energy when carbon dioxide and water are converted into carbohydrates.

Photovoltaic Process - The process by which radiant energy is converted directly into electric energy.

Pollution - Contamination or fouling of land, air, or water, by chemicals, heat, noise, atomic radiation, or wastes.

Potential Energy - Stored energy, as in a battery or water behind a dam.

Power - The rate at which energy is used or work is done, measured in units of energy per unit of time (calories per second) or in units such as kilowatts or horsepower.

Primary Energy - Energy in its natural form, such as coal or oil, before its conversion to end-use forms of energy, such as heat or electricity.

Radiation - The emission of energy through matter or space.

Reserves - Portions of a resource, such as oil, which have been discovered and can be extracted by available technology.

Resource - A product of nature which people use to satisfy their needs, wants, and dreams.

Second Law of Thermodynamics - In any energy conversion, some energy passed from a useful to a less useful form, usually lost heat, or "heat tax."

Smog - An atmospheric condition in which the air is polluted by smoke, fog, sulphur and nitrous oxides. Sulphur oxides react with water to form sulphuric acid droplets, which fall as "acid rain," causing great damage to marble and limestone buildings and statues, and to bodies of water which become too acidic to support living things.

Solar Cell - A device which converts solar radiant energy directly into electric energy by the photovoltaic process.

Solar Collector - A device for collecting solar energy and converting it into heat.

Solar Energy - The electromagnetic radiation transmitted by the sun. The earth receives about 4000 trillion kilowatt-hours per day.

Synthetic Natural Gas (SNG) - A gaseous fuel manufactured from coal, containing almost pure methane.

Tar Sand - A sandy geologic deposit in which oil is found.

Temperature - The "hotness" or "coldness" of a substance.

Thermal Pollution - Any increase in air or water temperature by waste heat from electric generating plants, which causes disturbances in the ecological system of an area.

Turbine - A motor turned by a powerful stream of water or gas.

Uranium - A radioactive, metallic element used as a fuel in nuclear power plant reactors to generate electricity.

Utility - A company or organization which provides services for people, such as gas, oil, or electricity.

Volt - The electromotive force which will cause a current of one ampere to flow through a resistance of one ohm.

Watt - A metric unit of power used in electric measurements of the rate at which work is done or energy used. One watt equals one Joule of work per second.

Work - The product of a force multiplied by the distance the force is applied or the object is moved.

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SOURCES OF ENERGY INFORMATION

AND

TEACHING MATERIALS

Office of Energy and Environmental
Education
Department of Education
Knott Building
Tallahassee, Florida 32301
(904) 488-6547

Governor's Energy Office
The Capitol
Tallahassee, Florida 32301
(904) 488-6931

American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209
(703) 524-2000

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, FL 32920
(305) 783-0300

National Coal Association
1130 - 17th Street, N.W.
Washington, D.C. 20036
(202) 628-4322

U.S. Department of Energy
Technical Information Center
Post Office Box 62
Oak Ridge, Tennessee 37830
(615) 483-8611

U.S. Department of Energy
National Energy Information Center
12th & Pennsylvania Avenue, N.W.
Room 1404
Washington, D.C. 20461
(202) 566-9255

U.S. Department of Energy
Education Programs Branch
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20 Massachusetts Avenue, N.W.
Washington, D.C. 30545
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Local Utility Companies

County Agriculture Extension Agency

Local, state and national environmental organizations

REVIEW SHEET (9-10)

This teachers' guide, Energy and My Environment (9-10), is for your review, field testing and comments. Your evaluation of these lessons will be sincerely appreciated and your suggestions considered for inclusion in a revised publication.

Sections of Guide Taught

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Are lessons appropriate for grade level? _____

Describe reaction of students. _____

Is there sufficient emphasis on teaching energy facts? _____

Is there sufficient emphasis on teaching values? _____

Your ideas for extending the lessons:

Grade ____ Unit ____ Lesson ____ _____

Grade ____ Unit ____ Lesson ____ _____

Grade ____ Unit ____ Lesson ____ _____

Please put additional ideas on back of review sheet; include the grade, unit and lesson numbers.

Other comments and suggestions: _____

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are some small, dark specks and faint smudges scattered across the surface, likely due to dust or imperfections in the paper or scanning process. No text or other markings are present on the page.

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Knott Building
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